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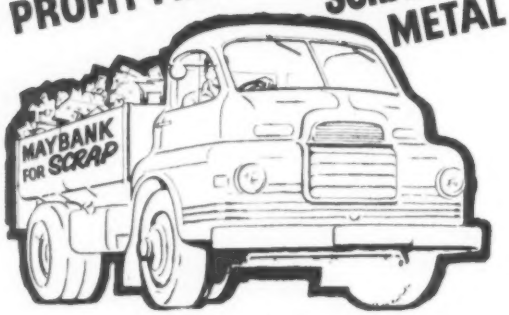

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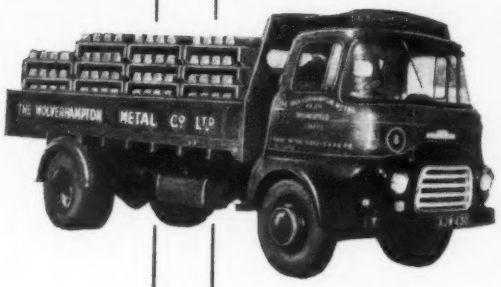

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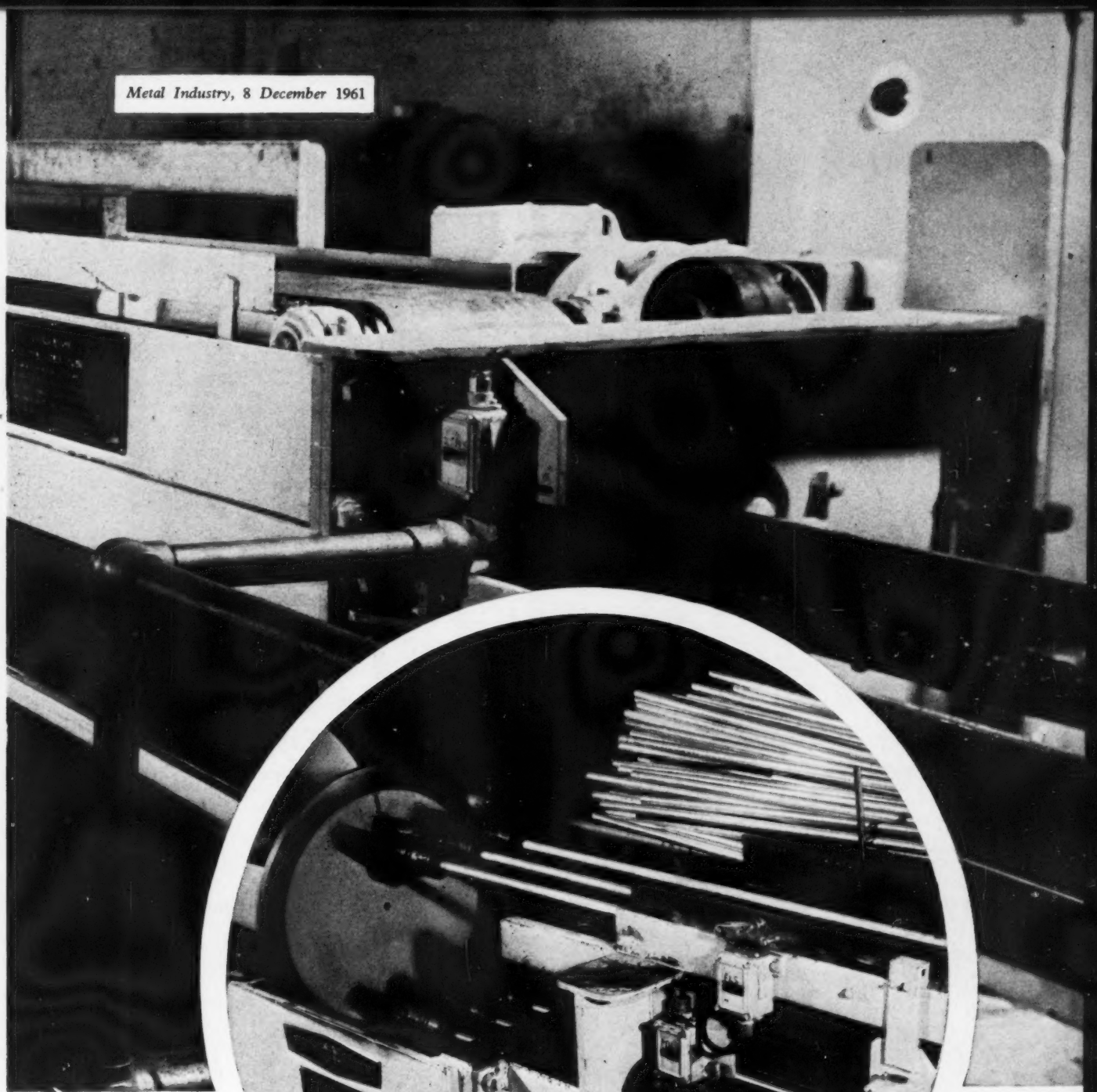

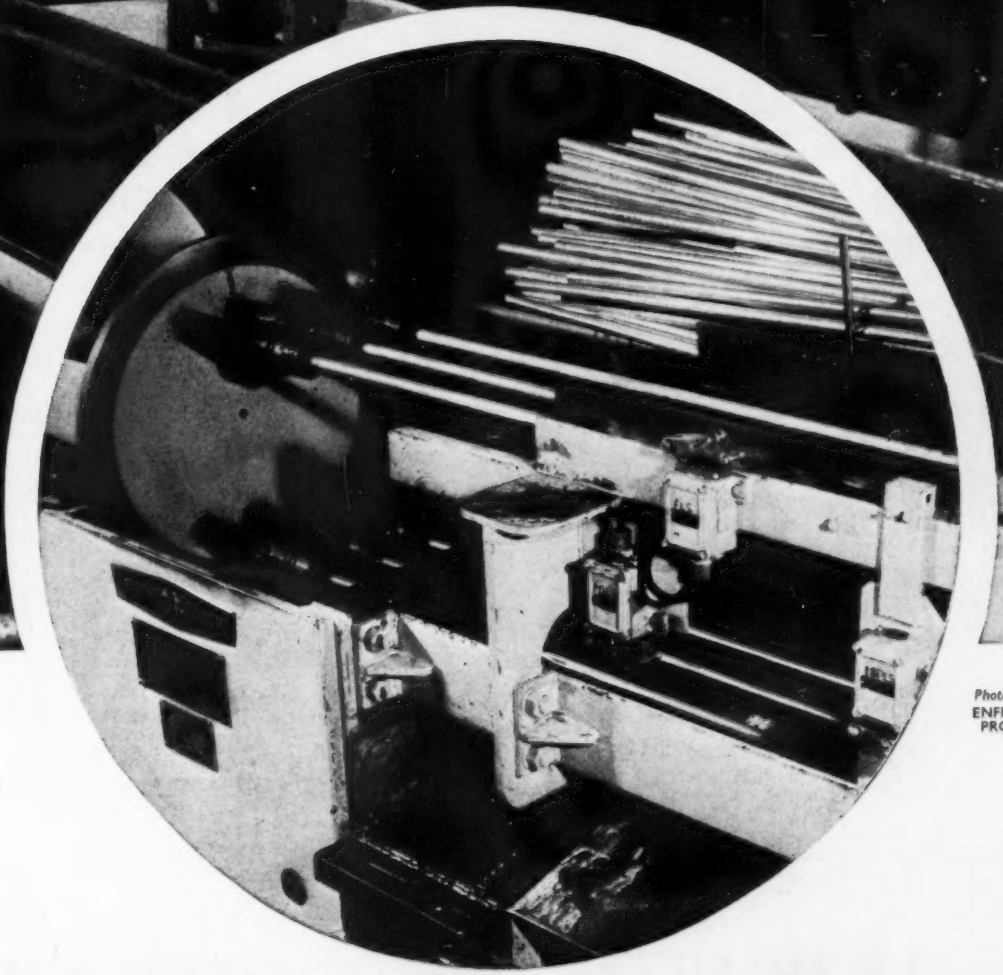

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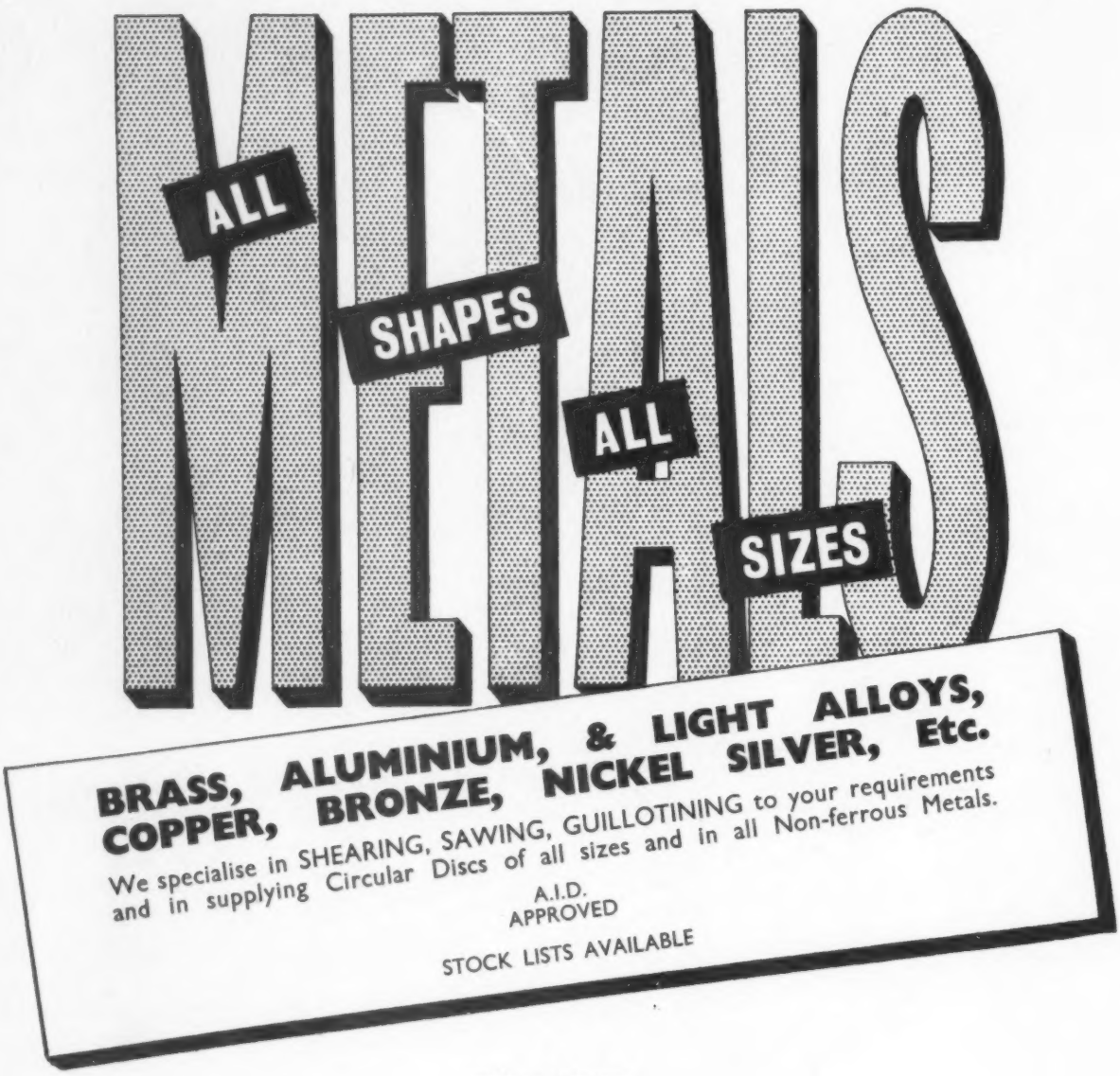

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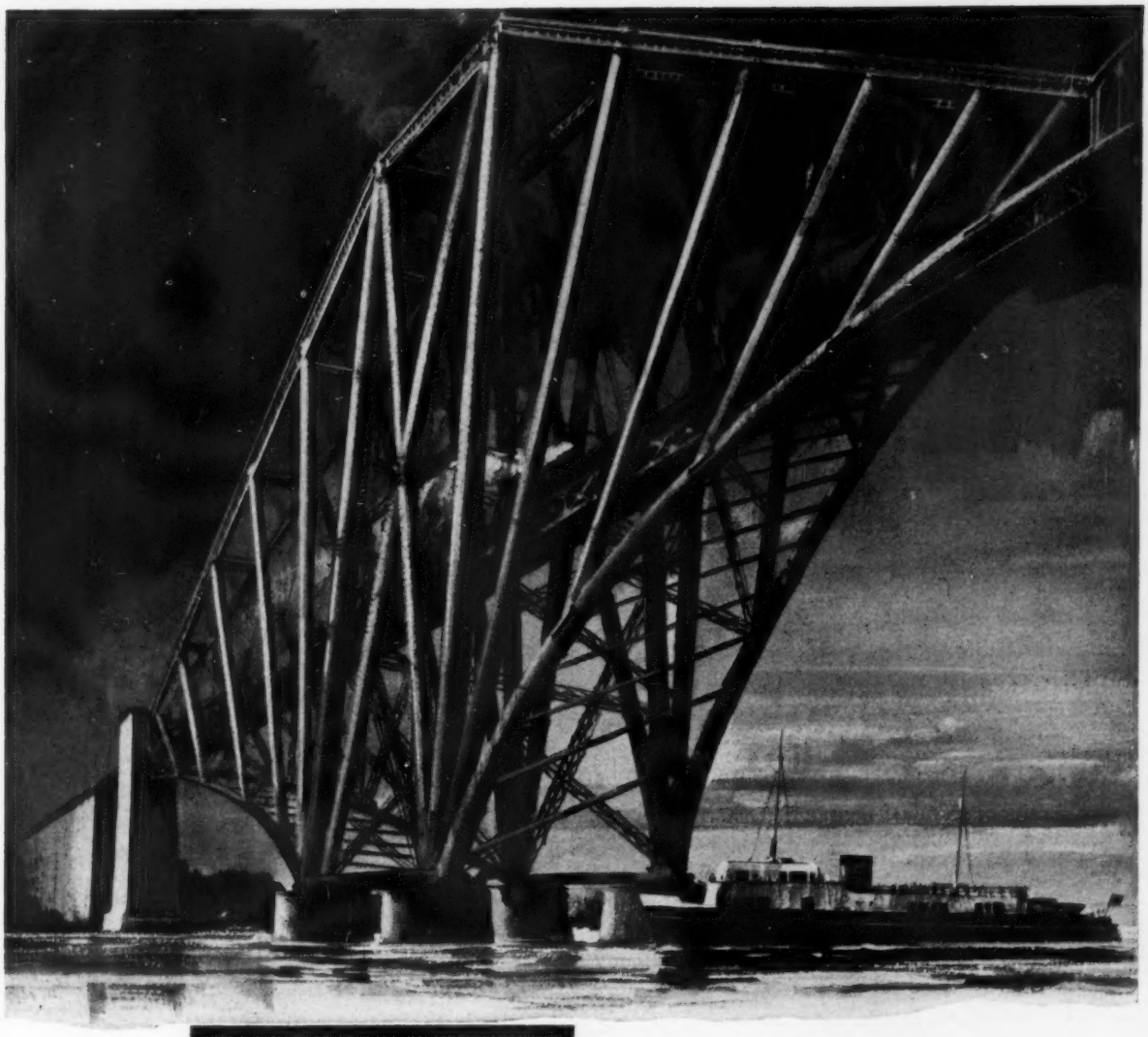

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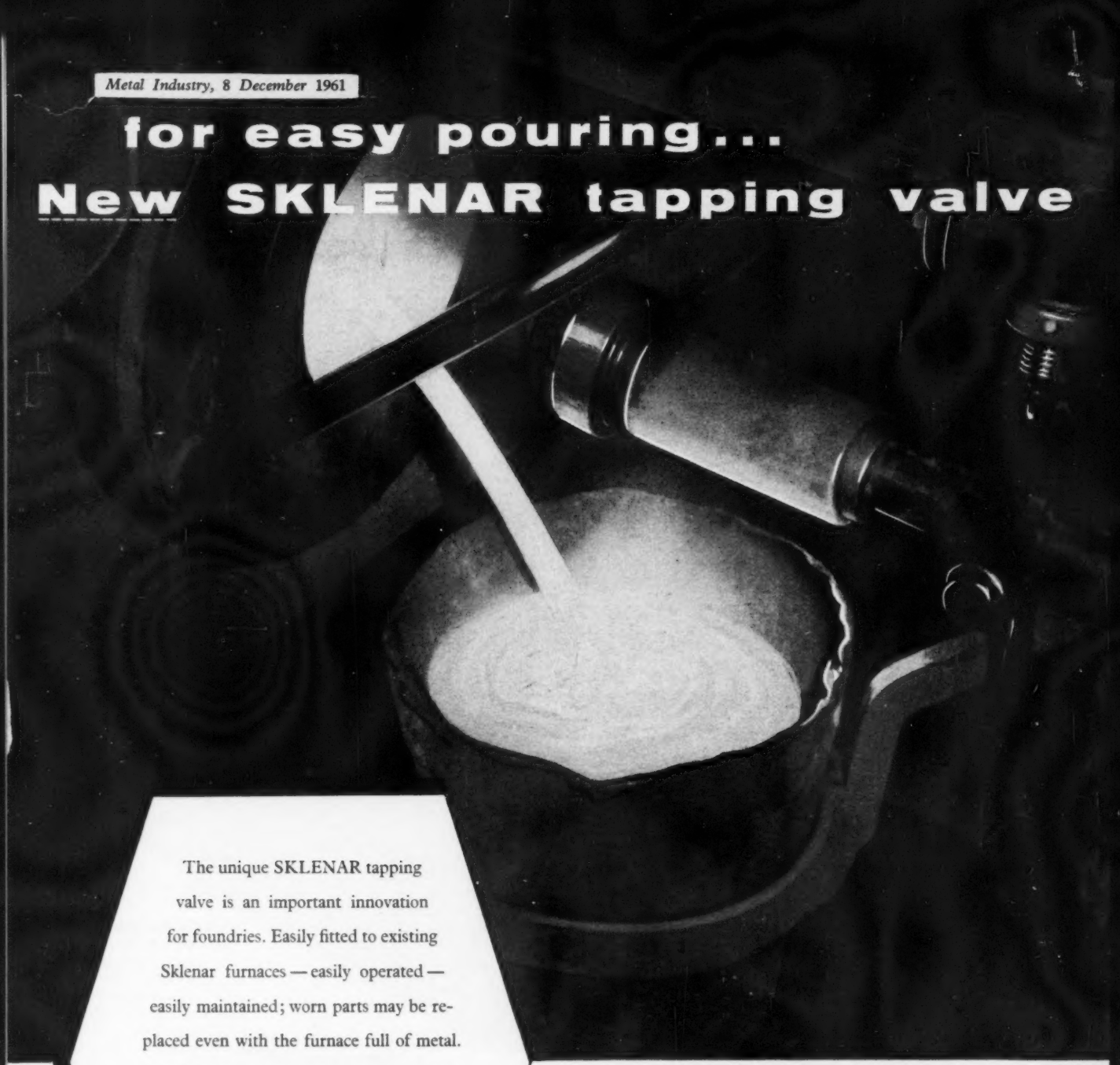

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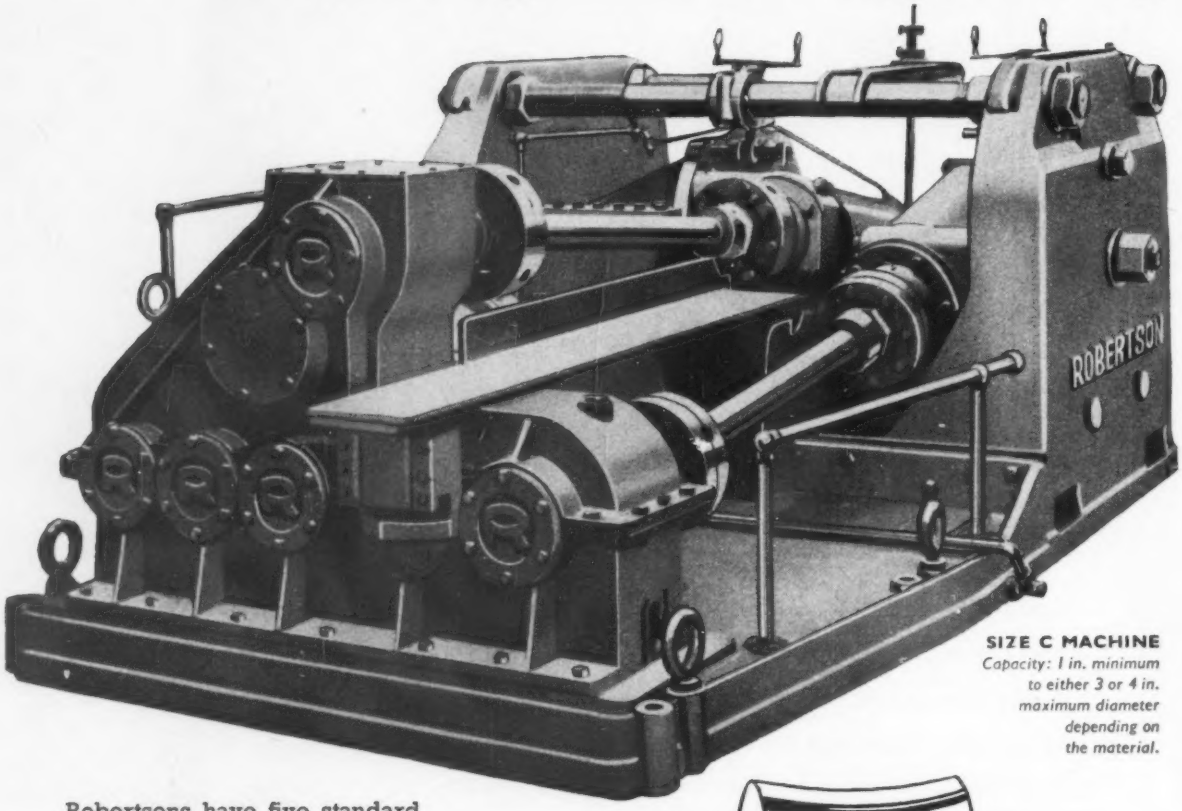

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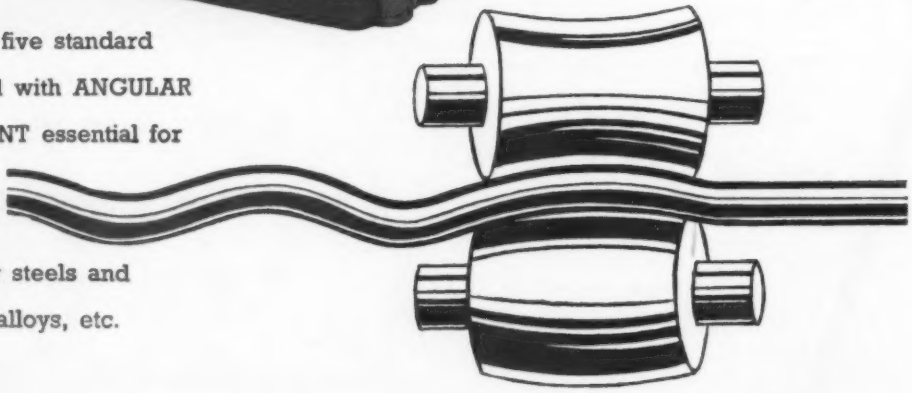

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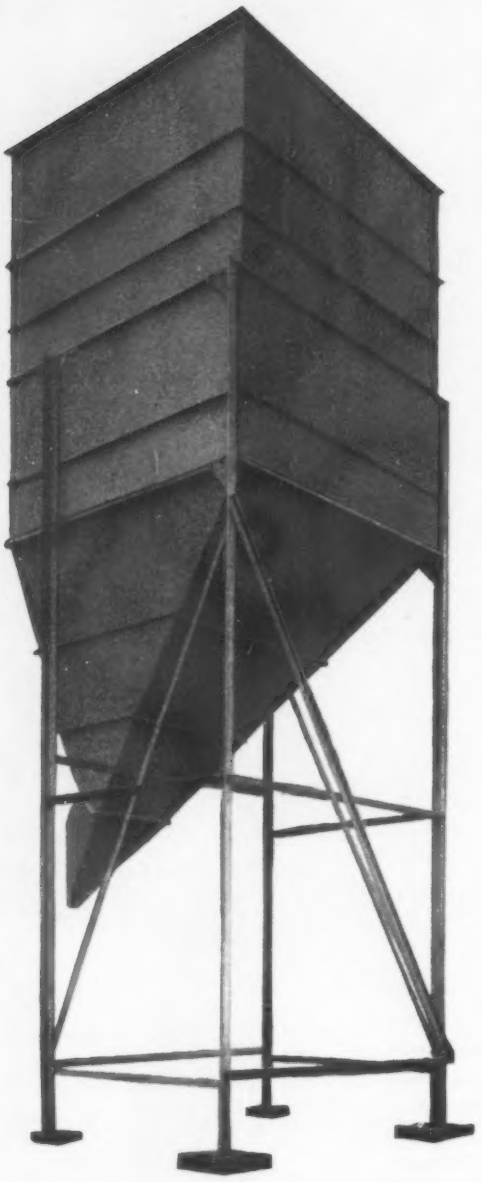

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Technical-Economic Forecasting

TOO often there is a strong tendency to invest in research as a means of "keeping up with the Jones's" without understanding its economic impact. Research can, and should, be beneficial if properly understood, managed, and controlled. There is no sense in continuing to invest in it merely as a matter of fashion. An intensive study of research and its relationship to the economic environment would, without any doubt, pay dividends.

A number of areas that might be investigated are suggested by Dr. George James, writing in the *Battelle Technical Review*. Companies might supplement their long-range planning with forecasts on what research is needed to strengthen their position in a future economic environment. Marketing surveys could be made to indicate whether new or improved products can be marketed profitably. Research appropriations might be based not on sales or competition, but on technical-economic forecasts that define needs and reveal opportunities. The efficiency of research operations might be better measured by the quantity of promising ideas and effective use of professional effort, rather than by the usual yardsticks used for production and other company operations.

On an industry level, Dr. James suggests that a method might be developed for using research spending to minimize business-cycle fluctuations. The effects of research on the industrial labour force could be investigated so that labour transitions could be anticipated and made with a minimum loss of productivity. Studies of the effect of new products on the service industries and of the effect of technological efforts on the definition of markets might also very well be conducted.

On the national level, subjects for investigation could include research as a cause of major dislocations in the economy and the effects of research on the buying habits of consumers. Internationally, studies might be made on the effect of research on foreign markets and foreign policy. All human society throughout history has been influenced by change. The magnitude of the changes and, indeed, the motivation for them, is a problem so large that no individual or institution has been able to muster the skills and capabilities needed to shed light on what brings about change in society. It is the view of Dr. James that a step in this direction can be taken through development of a rationale for research in its economic environment. Undoubtedly there is a strong need for a measured attack on the problems which relate research to its economic environment. Heretofore, too little effort has been devoted to this area. The better we can forecast the economic environment of the future, the more effective will be long-range planning for research and development activities.

Aluminium Alloys in Marine

By R. Harper
(*Birmidal Developments Ltd.*)

WHEREAS mechanical and physical properties can be reduced to a series of numbers, the behaviour of metals in various atmospheric and climatic conditions is more difficult to tabulate. It is because of this somewhat nebulous factor that the corrosion of metals is regarded with some suspicion by potential users. Corrosion testing is a difficult problem because if quick results are required then an artificial or accelerated test in the laboratory, such as the salt spray test, has to be used. For the purpose of this test, specimens are subjected to an air-atomized spray of a solution containing 3½ per cent of either sodium chloride or Tidman's salt in a closed cabinet. It has been found that this test is more effective if the spraying is carried out for a short period, say 1 or 2 hr., and then the specimen allowed to dry for the remainder of the 24 hr. Examination is carried out daily, and specimens are moved each day in the cabinet, so that any bad distribution of spray is nullified.

If tests are performed in a normal atmosphere or under actual service conditions, then it is usually a long time before the results of such tests are available.

It was with a view to obtaining some comparison between the laboratory salt spray test and outdoor exposure in a marine atmosphere that Birmid Industries Limited opened a marine atmosphere testing station at Beaumaris, Anglesey, in 1949. Test specimens on the racks at this station are shown at the head of the opposite page.

The initial tests were carried out with sand and gravity die-cast specimens in the aluminium and magnesium alloys then in common use. The specimens were 3 in. square and ¼ in. thick, with a fluted ray-like design sunk on one side (see Figs. 1-6). The diagonal line on the test specimens is a scratch to simulate accidental damage to the paint.

Twelve specimens of various alloys were exposed in groups of three in conjunction with four surface finishes thus: three specimens in each alloy, both sand and gravity die-cast, had the "as-cast" surface; three more specimens had one coat of an air drying zinc chromate primer on the as-cast surface; three more had the same primer treatment followed by a normal paint system of undercoat and finishing coat; the fourth finish was an anodized film without any subsequent treatment. This was produced in a 15 per cent sulphuric acid bath at 13°-17°C. at a voltage of 15. The time of anodizing was 30 min., followed by sealing in boiling water.

Racks to support the specimens were originally made in wood. After 4 yr. these collapsed and were replaced by racks fabricated from aluminium alloy extrusions. No surface protection at all was given to these. The specimens faced south-west—the direction of the prevailing winds—and were inclined at 30° to the vertical. The method of attachment was arranged so that there was no metallic contact between the racks and the specimens.

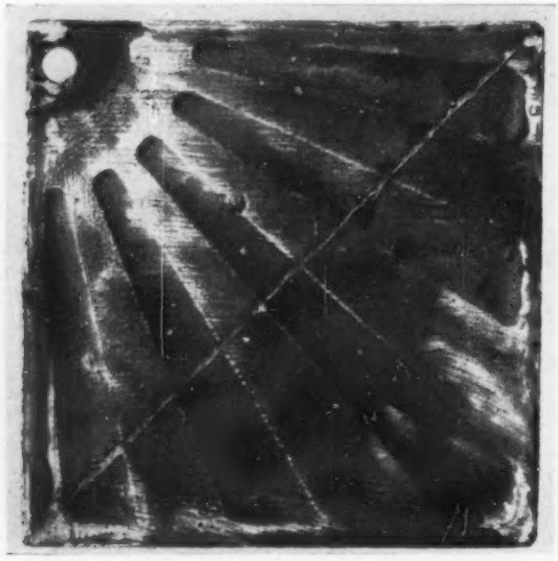
Examination of the specimens was carried out at regular intervals, and it was soon apparent that the period of atmospheric exposure equivalent to 1,000 hr. in the salt spray cabinet would extend over some considerable time. After ten years had elapsed, a more detailed examination was made and weight losses of metal and paint were determined. These are given in Table I.

From these figures and the observations made during the ten-year period much valuable information has been gained. It is evident that no direct significant comparison can yet be made between the marine atmosphere test and tests carried out in the salt spray cabinet.

In the case of painted specimens it is doubtful whether any comparison can be made owing to the complete absence of sunlight and weathering in the laboratory accelerated tests. With painted specimens, the effect of ultra-

Fig. 1—Specimen of LM4.M fully painted. Paint loss 0·35 gm. Metal loss 0·013 gm.

Fig. 2—Specimen of LM6.M fully painted. Paint loss 0·42 gm. Metal loss 0·030 gm.



Environments

General view of the marine atmosphere testing site at the Beaumaris station

violet light (sunlight) and weathering is more searching than salt spray alone. With specimens which have been anodized, it would appear from the records of metal losses, that in the salt spray test the anodic film had only just broken down towards the end of the 500 hr. This has been supported in certain tests which have been carried out where at 1,000 hr. the loss of metal has been five or six times greater than at 500 hr. Under marine atmosphere, the varying conditions may have made the breakdown more progressive.

The figures under each heading in Table I give an overall picture of the metal losses at the end of the 10 yr. period, and examination of the Table reveals certain interesting results. The column showing the loss in weight of the as-cast surfaces shows an order of merit which would be expected of the alloys concerned. Commencing with the most resistant alloy, the order is LM5, LM8, LM10, LM6, LM4, LM23, LM14, and LM1. A study of the figures obtained from anodized samples shows a different order of merit. These results are very interesting, as from them it would appear that under marine atmosphere conditions the process offers greater protection to the less "noble" alloys than to those renowned for their inherent resistance to corrosion.

In the course of examination, however, it was found that only LM5 and

TABLE I—WEIGHT LOSS OVER 10 YEARS (mg/cm²)

Alloy	Condition	As-cast Surface	Anodized Surface	Zinc Chromate Primer	Fully Painted	
					Paint Loss	Metal Loss
LM1	M	3·2	0·7	—	2·2	0·04
LM4	M	1·3	0·7	1·0	2·6	0·1
LM4	W	1·4	0·6	1·1	3·1	0·22
LM5	M	0·4	0·7	1·2	4·9	0·22
LM6	M	0·9	0·3	1·3	3·1	0·13
LM8	M	0·8	0·7	1·6	3·6	0·16
LM8	P	1·0	0·7	1·8	3·8	0·24
LM8	W	0·8	0·7	1·5	5·3	0·27
LM8	WP	1·0	0·6	1·3	3·2	0·13
LM10	W	0·8	1·8	—	18·4	0·53
LM14	WP	1·9	0·4	1·3	7·3	0·36
LM23	P	1·7	0·5	1·6	2·5	—

M—*Material in the as-cast condition.*

W—*Material which has been solution heat-treated, i.e. heated to* 500-540°C. *and then quenched in hot or cold water or oil.*

P —*Material which has been precipitation heat-treated, i.e. a low temperature treatment at* 100-180°C. *either after casting or after solution heat-treatment.*

Fig. 3—Specimen of LM8.WP fully painted. Paint loss 0·43 gm. Metal loss 0·018 gm.

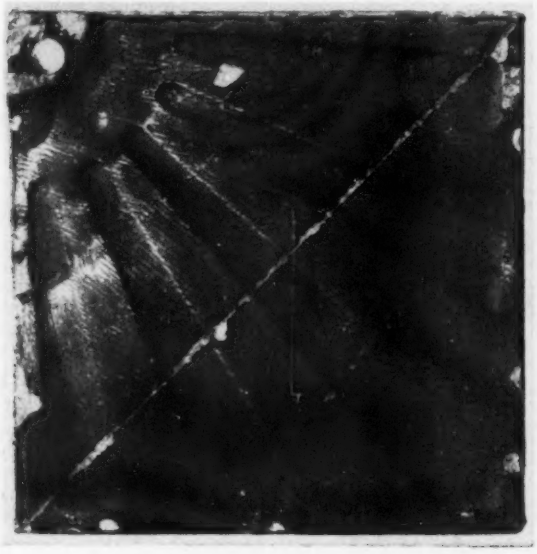


Fig. 4—Specimen of LM10.W fully painted. Paint loss 2·48 gm. Metal loss 0·071 gm.

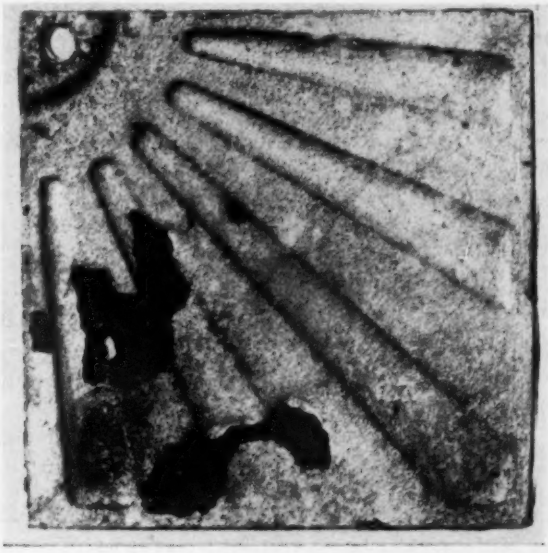


Fig. 5—Specimen of LM14.WP fully painted. Paint loss 0·98 gm. Metal loss 0·049 gm.

Fig. 6—Specimen of LM23.P fully painted. Paint loss 0·33 gm.

LM10 alloys had any electrical resistance remaining in their films; all the other alloys, without exception, offered no resistance to the passage of an electric current. This test indicated that the anodic film had completely broken down, due to weathering during the ten year period.

The painted specimens are of considerable interest. In the first place, the specimens which were treated with one coat of zinc chromate primer were quite outstanding in this test, the total weight loss being considerably less than that which occurred on those samples that had been fully painted.

From the adhesion point of view, it was noted that the alloys which are generally recommended for their good resistance to corrosion showed poor adhesion quality, while the less resistant alloys showed the best adhesion of the paint films.

It is not to be expected that a painted surface will give protection for an indefinite period, and it was noticeable that after about 5 yr. the paint lost its protective value and tended to act as a sponge to hold moisture and thereby accelerate corrosive action.

Table III gives paint and metal losses with the various alloys. It should be remembered that the weights quoted here represent a total loss over the surface area of 21 in^2 (135·5 cm^2).

Effect on Mechanical Strength

While the visible products of the process of corrosion may be obvious, they can be misleading, making interpretation difficult, but to the engineer the effect of corrosion upon the strength of a component is of the utmost importance. With this in mind, a series of tests was started in 1951 using 0·564 in. diameter standard tensile test bars in a number of popular alloys to B.S.1490: LM4.M, LM5.M, LM6.M, LM8.M, P, W, and WP, LM10.W, LM14.WP, and LM23.P.

Twelve test pieces in each condition of these alloys were produced and machined to the British Standard for the 0·564 in. diameter bar. Three of each were taken at random and tested, the average result of each set of three bars being taken as the control figure and comparator for ultimate tensile and elongation.

The remaining nine bars of each were then given a protective coat of primer at each end only in order to prevent corrosion taking place on the grip portion of the bar, which would have upset the true axial loading of the bar when finally tested after exposure.

All the bars were then exposed to marine atmosphere in insulated racks, of the type seen in the illustration (Fig. 7) on the same site as the tile specimens already referred to. It was originally intended to withdraw these bars in groups of three at annual intervals for tensile test, but as no change was reported after 1 yr., it was then decided to spread the period, and the bars were accordingly withdrawn at 1 yr., 3 yr. and 5 yr. The results given in Table IV are self-explanatory.

TABLE II—COMPARISON BETWEEN SALT SPRAY AND MARINE ATMOSPHERE

Alloy	LOSS IN WEIGHT			
	Untreated Surface		Anodized Surface	
	Salt Spray (gm/500 hr.)	Marine Atmosphere (gm/10 yr.)	Salt Spray (gm/500 hr.)	Marine Atmosphere (gm/10 yr.)
LM1.M	0·87	0·43	0·06	0·09
LM4.M	0·34	0·18	0·02	0·09
LM5.M	0·19	0·06	Nil	0·10
LM6.M	0·05	0·12	Nil	0·04
LM14.WP	0·14	0·25	Nil	0·06
LM23.P	0·26	0·23	0·02	0·07

TABLE III—PAINT AND METAL LOSSES

Alloy	Weight Losses	
	Paint gm/10 yr.	Metal gm/10 yr.
LM1.M	0·29	0·005
LM23.P	0·33	—
LM4.M	0·35	0·013
LM4.W	0·42	0·030
LM6.M		0·017
LM8.WP	0·43	0·018
LM8.M	0·49	0·022
LM8.P	0·51	0·032
LM5.M	0·66	0·028
LM8.W	0·71	0·036
LM14.WP	0·98	0·049
LM10.W	2·48	0·071

Contact with Other Metals

While these mechanical tests were in progress, it was decided to carry the work a stage further by testing the same range of alloys, exposed to marine atmosphere but in contact with other metals. These tests were designed to show the effect of coupling light alloys

TABLE IV—EFFECTS OF CORROSION ON MECHANICAL STRENGTH

Alloy	Casting Method	Control Bars		After 12 months Exposure		After 3 years Exposure		After 5 years Exposure	
		U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)
LM4.M	Sand	10·9	2·4	11·4	1·6	11·6	1·5	11·5	1·4
LM4.W	Sand	14·5	2·4	16·3	1·5	16·8	1·6	16·4	1·2
LM4.M	Chill	12·0	3·6	12·9	2·7	13·4	2·7	12·4	1·1
LM4.W	Chill	15·0	4·8	16·2	2·7	15·6	2·7	16·4	1·8
LM5.M	Sand	12·0	7·6	12·0	6·7	12·5	7·6	12·4	6·1
LM5.M	Chill	16·4	22·0	16·3	19·0	16·6	22·0	16·5	20·0
LM6.M	Sand	11·4	8·5	11·2	8·0	11·4	7·4	10·7	6·8
LM6.M	Chill	13·6	12·5	13·8	13·2	13·8	15·2	13·0	11·9
LM8.M	Sand	8·5	2·4	8·5	2·5	8·9	1·6	8·8	2·0
LM8.P	Sand	10·0	1·4	9·8	1·3	10·1	1·3	10·1	1·1
LM8.W	Sand	11·0	3·0	11·5	2·8	11·4	2·7	11·2	2·9
LM8.M	Chill	11·5	10·4	12·3	10·7	12·7	11·8	12·8	11·3
LM8.W	Chill	16·2	12·8	16·8	15·5	15·6	8·6	16·4	13·2
LM8.WP	Chill	20·3	8·8	19·7	6·7	20·4	6·4	19·4	4·1
LM10.W	Sand	18·6	9·2	19·5	5·8	20·7	4·5	21·6	4·9
LM10.W	Chill	22·4	29·0	21·8	21·0	21·7	23·0	21·3	16·0
LM14.WP	Sand	16·6	0·8	16·9	1·1	16·7	0·9	16·1	1·2
LM14.WP	Chill	19·8	2·6	20·6	1·8	20·4	1·5	19·1	1·3
LM23.P	Sand	12·2	2·6	11·8	2·7	12·2	1·7	12·0	2·2

with ferrous and cuprous alloys. The light alloy specimen again took the form of a B.S. 0·564 in. dia. test bar, and around the centre of the gauge length of each bar, a clip of heavy metal was held in position by two nuts and bolts of the same metal as the clips, i.e. steel and brass respectively (Fig. 8). All metallic surfaces were clean and free from grease. The ends of each test bar were again given a coat of zinc chromate primer to prevent corrosion at these points. The same type of rack was used as that for the bars previously reported, with adequate insulation between the rack and the specimens under test. The tests were carried out in exactly the same manner as those mentioned earlier, groups of three bars being withdrawn for testing after 1 yr., 3 yr. and 5 yr. respectively.

When the first group of bars was withdrawn for mechanical testing it was found that all the steel clips were badly corroded and it was impossible to remove the nuts and bolts holding them without cutting them with a hacksaw. The brass clips were not so badly affected by the exposure, and the nuts and bolts were able to be removed by the use of a small screwdriver.

After five years' exposure, there were visible signs of corrosion on all the specimens, alongside the heavy metal clips. Removal of the clips and cleaning of the light alloy test bars revealed that the attack on the light alloy was slight and was confined to the area beneath the joint line between the two half clips and around the edges of the clips. This is shown in the photograph of two LM4.M tests bars (Fig. 9).

The results of the tensile tests on the aluminium alloy tests bars after the

Left: Fig. 7—Aluminium exposure test rack with tensile test bars in position

Below: Fig. 8—Test bar with brass clip in position for bimetallic test

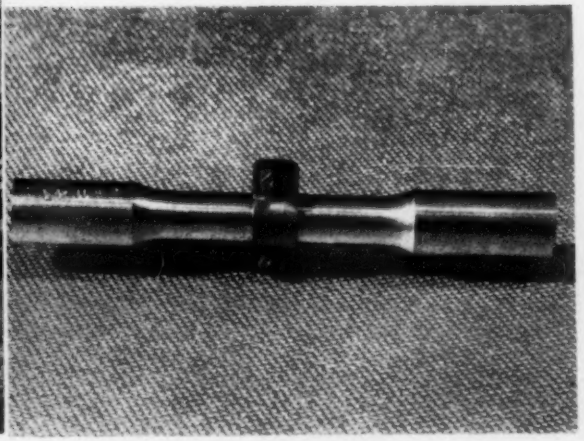


TABLE V—EFFECT OF CORROSION ON ALUMINIUM ALLOYS COUPLED WITH STEEL

Alloy	Casting Method	Control Bars		After 12 months Exposure		After 3 years Exposure		After 5 years Exposure	
		U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)
LM4.M	Sand	9·6	2·2	10·1	1·1	10·0	1·0	10·6	1·0
LM4.M	Chill	12·4	3·3	12·7	1·7	11·1	1·7	—	—
LM5.M	Sand	10·9	4·4	10·9	5·0	10·1	4·5	11·2	5·0
LM6.M	Sand	11·9	8·1	11·6	5·5	12·0	8·2	11·7	8·0
LM8.W	Sand	11·5	3·1	11·7	1·2	12·3	1·1	12·0	1·5
LM8.W	Chill	16·0	10·8	14·0	3·9	14·4	4·2	14·2	3·0
LM10.W	Sand	18·9	11·4	19·6	6·0	21·0	4·4	19·4	2·5
LM10.W	Chill	22·9	27·0	21·3	16·6	20·2	9·7	21·7	9·0
LM14.WP	Sand	15·4	0·6	16·3	0·6	14·5	0·7	14·7	Nil
LM14.WP	Chill	21·3	2·2	19·0	1·0	19·1	0·9	20·1	1·0
LM23.P	Sand	11·0	3·0	10·8	2·4	10·8	2·3	10·9	2·5

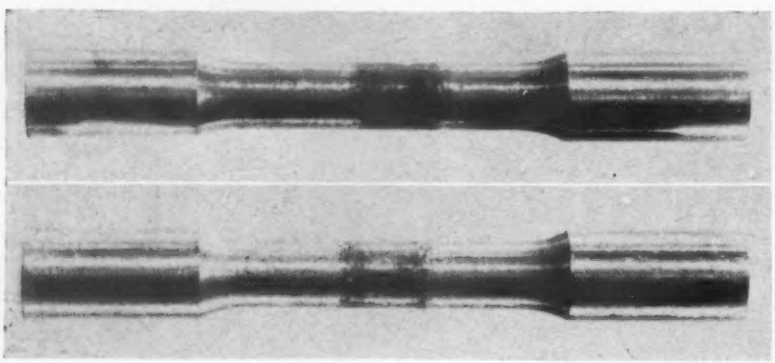
TABLE VI—ALUMINIUM ALLOYS COUPLED WITH BRASS

Alloy	Casting Method	Control Bars		After 12 months Exposure		After 3 years Exposure		After 5 years Exposure	
		U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)	U.T.S. (tons/in²)	Elong. (per cent)
LM4.M	Sand	9·6	2·2	10·2	1·1	9·9	1·6	10·3	1·0
LM4.M	Chill	12·4	3·3	12·7	1·7	13·5	1·6	12·2	1·0
LM5.M	Sand	10·9	4·4	10·9	5·0	10·2	5·0	10·2	4·5
LM6.M	Sand	11·9	8·1	11·6	5·5	12·0	7·9	11·7	8·0
LM8.W	Sand	11·5	3·1	11·7	1·2	12·3	0·6	11·2	1·5
LM8.W	Chill	16·0	10·8	14·0	3·9	14·8	4·4	14·2	4·0
LM10.W	Sand	18·9	11·4	19·6	6·0	21·2	5·3	21·4	3·5
LM10.W	Chill	22·9	27·0	21·3	16·6	22·7	15·5	22·3	10·0
LM14.WP	Sand	15·4	0·6	16·3	0·6	15·2	0·7	14·4	Nil
LM14.WP	Chill	21·3	2·2	19·0	1·0	19·7	0·9	18·2	0·5
LM23.P	Sand	11·0	3·0	10·8	2·4	10·9	2·8	11·4	2·5

three exposure periods are given in Tables V and VI showing the U.T.S. and elongation of the various alloys after contact with steel, and brass clips.

All figures quoted in the Tables are the average of the results of three tests except in the case of the 5 yr. figures, where only one test was made of each alloy. In view of the results obtained from the one test bar, it was decided that further exposure of the remaining two test pieces of each alloy would be of greater value than confirmation of the 5 yr. figures. There is little significant loss of strength over the period of test, but there is a tendency for the steel clips to cause a greater loss in strength than the brass clips, which is a contradiction of usually accepted theories.

Fig. 9—Test bars of LM4 after removal of (top) steel clip and (bottom) brass clip



The programme already carried out has enabled observation to be made on the visible results of corrosion and its effect on the strength of aluminium alloys to be measured. It is hoped that the work will have helped to remove some of the cloud of uncertainty through which corrosion problems are sometimes viewed.

A companion series of tests on magnesium alloys has been carried out by Birmid Industries Limited during the same period, and the results obtained from these tests will form the subject of a further report.

The author thanks the directors of Birmid Industries for their permission to publish this report and his colleagues for their help in its preparation.

Lead and its Alloys

By J. F. Holmes, A.I.M.

REVIEW OF MECHANICAL AND PHYSICAL PROPERTIES AND USES

LEAD possesses an unusual combination of properties, which have rendered it useful from the earliest times. It is soft and malleable and can be easily worked, rolled and extruded. It has a low melting point and a high boiling-point, a high density and excellent resistance to corrosion by a wide variety of media, and is relatively cheap.

The mechanical properties of lead and its alloys, however, are not as easily assessed as, for example, those of mild steel, as structural changes can occur. It can be misleading to compare the results of tests carried out under different conditions without a full knowledge of the test conditions.

Grain size, grain growth and recrystallization are of importance in regard to the mechanical properties, and some alloys have the property of age-hardening and some of work-hardening. It is, accordingly, necessary to know such factors as the rate of strain, extrusion rates and temperatures, cooling and ageing periods, to assess quoted figures.

The tensile strength (1,750-1,900 lb/in^2) and ductility of lead in the pure state are low in comparison to other metals used for constructional purposes and have to be taken into account in the design of structures and components in which lead is used for its valuable properties. Furthermore, lead has a low creep resistance, and the creep strength has to be considered in design rather than the ultimate tensile strength. Whereas a lead alloy may have an ultimate tensile strength of some 3,000 lb/in^2, a stress of only 500 lb/in^2 might suffice to cause failure if applied for a long period.

In many applications, it is possible to obtain adequate strength by reinforcement. For example, when large areas of lead lining are used, as in the chamber process of manufacturing sulphuric acid, steel strips can be placed over the lining at intervals and bolted on to the walls. Such strips are then covered with lead, which is "burned" on to the lining.

Steel can be clad with lead by cold-rolling, by melting the lead on to the previously tinned surface and building up to the required thickness or by flame-spraying the lead on to the steel.

Vessels, pipes, pumps, valves, fittings and pumps for corrosion-resistant use in the chemical industry are cast from "regulus metal", alloys of from 7-15 per cent of antimonial lead. Regulus metal with the higher percentages of antimony can be screwed.

Lead is ideal for sheathing and piping as it can be extruded in lengths as required, can be bent and curved as necessary when being installed, and can adapt itself to contours without fracturing.

The high density of lead, 11·3 gm/c.c. at 20°C., has rendered it useful for sinkers, keels, counterbalance weights, shot, bullet-cores and in nuclear shielding. In this connection, it is interesting to note that Russian experiments at pressures of 400,000 atmospheres and over have resulted in increases of 200 per cent in the density of lead.[1]

Lead has been used in building for hundreds of years for roof-coverings, gutters, flashings, cast rainwater pipes and pipe-heads, and is now used for damp-courses and for damping vibration in the foundations of skyscrapers.[2,3]

Pure lead is very soft (Brinell Hardness 3·5-4·0) and can be easily cut and shaped. This property leads to its use in the Trauzl or Lead Block test for comparing the power of high explosives. The explosives are detonated in a central bore-hole of a 200 mm. diameter block of pure lead, 200 mm. high, and the volume of the enlarged cavity determined.

In investigations on the hot-rolling of steel, Loizou and Sims[4] carried out a series of tests on the yield strengths of pure lead in compression. Cold lead was used as a model for hot steel; they found that "Barrelling" of the test specimens could be prevented by machining concentric grooves in the ends of the specimens and lubricating them.

The creep of lead and lead alloys was studied in some detail by Gifkins[5], who found that over a fairly wide range of strain rates, pure lead deforms by a combination of boundary migration and various internal adjustments, and that recrystallization is a factor only with grain sizes greater than 0·1 mm. diameter. With lead sufficiently hardened by alloying additions, e.g. over 10 per cent thallium or 0·05 per cent tellurium, the probability of internal adjustments is lower and local stress concentrations may then lead to the initiation of cracks at the boundaries.

The same author[6] determined the strain necessary to initiate recrystallization during the creep of very pure lead for stresses of from 300 to 1,500 lb/in^2. Recrystallization was found to occur at higher strains with higher stresses, and the recrystallized grain size decreased with the increase of stress.

Commercial lead has a fatigue strength of some 380 lb/in^2 in the rolled condition. Tests by Snowden and Greenwood[7] suggested that fatigue *in vacuo* causes more surface deformation than fatigue in air, even though fatigue life is greater.

Lead improves in mechanical properties with diminishing temperature, as would be expected from its face-centred cubic lattice. Pomp *et al*[8] reported the results given in Table I for pure lead.

Lorig[9] showed graphically, from figures by Teed[10] and Siegle and Brick,[11] that the tensile strength of lead and some other metals increases at a somewhat accelerated rate as the temperature decreases. Trends in the elongation, reduction of area and impact strength properties were also plotted and ductility shown to be rather improved as is the toughness of lead at low temperatures.

Grain size has a marked effect on the strength and the creep-resistance of lead and lead alloys, and very small additions of alloying elements can have a profound effect on these properties. Generally, an alloy with a fine grain size has a better fatigue resistance than an alloy with a coarse grain structure. An increased creep strain is found with fine grain sizes over long term tests.

Antimonial Lead Alloys

The alloying addition most used for lead is antimony, which confers hardness and increases the tensile strength of the metal. The equilibrium diagram of the lead-antimony system is a classically simple one but difficulties have been experienced in examining the solidification of alloys, especially those containing around the eutectic composition, pronounced segregation being found in slowly cooled solutions, even with small amounts of antimony present.

The eutectic composition has been given as from 11·1 to 13·0 per cent of antimony,[12] and Blumenthal's value[13] of 11·1 per cent at a eutectic temperature of 252°C. is used in the Institute of Metals Equilibrium Diagram.[14] The solid solubility of antimony in lead is given as 3·45 per cent at the eutectic temperature and 0·3 per cent at 50°C.

"Hard lead", as antimonial lead is known, is used in large quantities for the grids of storage batteries, which

generally have an average content of 7 per cent antimony. In 1960, some 39,997 tons of lead (10·55 per cent of the total consumption) were used in the form of metal in storage batteries in the United Kingdom.

Antimonial lead also finds employment in lead sheathing for cables, castings, bearing metals and as pipes, fittings, linings and coatings in the chemical industry, where its greater strength, combined with good corrosion resistance render it valuable.

One of the most interesting technical features of the lead-antimony alloys is their property of "age-hardening". If these alloys are heated to above their solid solubility temperature and then quenched, they show a marked increase in hardness on ageing, the extent of the increase being dependent on the amount of antimony present and the rate of cooling.

Reported figures of the tensile properties of the antimonial leads show an extremely wide range of variation; for example, tensile strengths of 6,840 to 15,322 lb/in² have been given for 6 per cent antimonial lead in the chill-cast condition.

Dean and others[15] investigated the effects of age-hardening of the antimonial lead alloys. Considerable increases in hardness and tensile strength, and even greater increases in the fatigue strength were found. The increased strength and hardness are shown in Table II from results by Hoyt[16] for 4 per cent antimony-lead as rolled and after heating to 235°C., quenching and ageing one day.

It was found, however, by Hopkins and Thwaites[17] that when lead of 99·994 per cent was used to make a 1 per cent antimonial lead alloy, no age-hardening effect could be produced. Additions of 0·01 per cent of tin and of 0·01 per cent copper did not produce any age-hardening, but normal age-hardening occurred on the addition of 0·001 per cent of arsenic or silver.

Supercooling and inverse segregation in lead-antimony alloys were studied by Simon and Jones,[18] whose experiments confirmed previously reported inverse segregation of antimony in lead-antimony alloy castings.

Tellurium-Lead Alloys

An addition of 0·04-0·06 per cent of tellurium to lead and lead alloys gives a finer grain size, probably by raising the recrystallization temperature and renders the alloys capable of cold-working.

An alloy containing 0·06 per cent of tellurium can be cold-worked from an initial strength of 3,000 lb/in² to as high as 5,000 lb/in², which is retained over months or years.[19] Pipes of tellurium-lead work-harden by water-hammer, vibration or bending, and resist bursting by freezing much better than pipes of soft lead or antimonial lead.

Tellurium lowers the creep strength of lead, but this can be corrected by the addition of small quantities of copper; the creep strength is, however, retained better at high temperatures than is the case with lead or the antimonial lead alloys.

An ultimate tensile stress of 3,000 lb/in² and an elongation of 40 per cent are average, though considerable variation is found in published results, particularly as regards the varying forms, i.e. cast, annealed, rolled and extruded.

Greenwood and Worner[20] investigated the constitution of dilute alloys of lead with tellurium and found that the eutectic contained 0·025-0·04 per cent of tellurium with a melting point 0·7°C. below that of pure lead. The limit of solid solubility at 300°C. was 0·004-0·0065 atomic per cent.

Pelzel[21] also studied the solubility of tellurium in molten lead and found it to be 0·25-0·10 per cent (400°-775°C.).

It is of interest to note that the use of a tellurium-lead alloy for electrical conductor elements of high thermo-electric power was patented.[22] Alloys containing 61·95 per cent or 65 per cent of lead are specified for a negative element, and 58·0 per cent or 61·8 per cent for a positive.

Lead Pipe Alloys

Lead is widely used for the manufacture of pipes and traps, either alone or alloyed with antimony, tellurium, or with silver and copper. The relevant British Standard Specifications covering lead and lead-alloy pipes are[23]: B.S. 602 : 1956 and B.S. 1085 : 1956, "Lead Pipes for other than Chemical Purposes"; B.S. 334 : 1934, "Chemical Lead Types A and B".

The lead pipe is generally produced by upward extrusion under hydraulic pressure and is coiled as it is produced. The experimental pressure and velocity fields for the inverted extrusion process with commercially pure lead were investigated by Thomsen and Frisch[24].

Resistance to creep under water pressure is the prime consideration in water pipes, and fatigue resistance is also of importance.

Hack[25] gives the formula:

$$P=\frac{2ST}{D}$$

for calculating the safe working pressures for lead pipe of chemical lead (American "chemical lead" is undesilverized lead with a maximum of 0·08 per cent copper) or 6 per cent antimonial lead, where

P = the safe working pressure.
S = the maximum allowable fibre stress in lb/in².
T = the internal diameter in inches.

The Lead Industries Association[26] gives the figures in Table III for allowable fibre stresses in pipes.

Laidler[27] quotes the Lame formula for thick-wall cylinders for calculating the pipe-wall stress in lead:

$$S=\frac{D^2+d^2}{D^2-d^2}P \quad \text{where,}$$

S = the stress in the pipe wall in lb/in².
P = the internal pressure in lb/in².
D = the external diameter of the pipe in inches.
d = the internal diameter of the pipe in inches.

and where the usual limit of a maximum wall stress is 220 lb/in² for Type "A" lead and 250 lb/in² for Type "B" lead containing 0·06 per cent copper.

TABLE I—PROPERTIES OF PURE LEAD

Temperature °C.	Tensile Stress Tons/in²	Elongation (per cent)	Impact Value ft-lb.
Room	1·3	33	2·3
−184	2·8	40	3·8
−254	—	—	4·5

TABLE II—LEAD-4 PER CENT ANTIMONY ALLOY

	Tensile Strength lb/in²	Elongation (per cent)	Hardness, Brinell	Endurance Limit lb/in² 20×10^6 cycles
Cold rolled	4,020	48·3	8·1	1,500
Heated to 235°C. Quenched and aged 1 day	11,670	6·3	24	—

TABLE III—ALLOWABLE FIBRE STRESS (lb/in²) IN EXTRUDED PIPE

Temperature °C.	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Chemical Lead	200	190	180	172	162	153	144	136	127	118	110	100	90	80
6 per cent Sb Lead	400	370	340	310	280	254	222	195	165	137	110	80	50	—

Neal[28] describes the use of thin-walled lead tube wrapped in bronze reinforcing tape and corrosion-resistant servings for use at working pressures of 350 lb/in^2, and mentions the possibility of the delivery of such pipe in 200-yard lengths on standard cable drums.

Cable-Covering Alloys

More lead is used for cable covering in the United Kingdom than for any other purpose; in 1960, 95,508 tons, or some 25·3 per cent of the total consumption, was employed in this way.

Lead is ideal for this purpose as it is impervious to moisture, has excellent resistance to corrosion and can be extruded by intermittent or continuous processes at temperatures of 250°C. or less, without danger of damage to the paper or rubber insulation. The sheathed cable can be reeled or bent without damage.

Cable sheathing alloys should have good ductility under slow creep conditions, a fine-grain structure and high fatigue resistance. A great deal of research has been devoted to the production of alloys of improved creep and fatigue strength in recent years.

Chivers,[29] in a Paper on the fatigue failure of the lead sheathing of telephone cables, gave instances of different types of such failures. A type of failure caused by flexural vibration was generally found in cables that had been in service and often suspended on the walls of buildings. In this type, cracks ran more or less around the girth of the cable. Longitudinal cracks, generally found on cables that had not been in service, and intercrystalline cracking on the interior surface of the cable sheath were attributed to vibration in transit. An example of cracking of the sheath exterior, known as "hot shortness" and due to extrusion at too high a temperature, was also given.

British Standard 801:1953 specifies the composition of lead alloys for cable sheathings; a minimum amount of 0·05 per cent antimony is specified for dry-core telephone cables to provide resistance to vibration in transit and use.

For operation under conditions of moderate or severe vibration, alloying additions are specified to inhibit fatigue-cracking. The antimonial lead alloy, B.S.801 Alloy D, is more resistant to severe vibration, and has a higher fatigue resistance than the lead-antimony-tin Alloy E, but requires higher extrusion pressures. A lead-antimony-cadmium alloy, Alloy D, is also specified for conditions of vibration, which has been reported as having an ultimate tensile strength of 1·64 tons/in^2 at 0·1-0·25 in/in/min. and a fatigue strength of 0·74 tons/in^2 at 10^7 cycles.

Atkinson and others[30] described creep and fatigue characteristics of an arsenical tin-copper-lead alloy for a cable sheathing. This alloy, with 0·10-0·17 per cent arsenic, 0·09-0·13 per cent tin and 0·04-0·06 per cent copper is reported as having a lower creep rate than the normal copper-lead alloy and was found to possess adequate tensile strength, good ductility and freedom from ageing.

Tests conducted in Denmark on 1 m. lengths of Møllerhøj,[31] or flat oil-filled super-tension cable, showed that at a frequency of one cycle per day and a strain of 0·25 per cent, fracture of the sheath could occur after only three years when pure lead sheath was used. With an alloy of 0·2 per cent tin and 0·075 per cent cadmium, the life was increased to six years, or if oxygen was extracted from the oil, to 40 or 50 years. A 0·06 per cent copper-lead alloy was also found to be suitable for sheathing such cable.[32]

A 0·04 per cent calcium-lead has been successfully used for cable sheathing, the calcium giving strength without the loss of too much ductility or pliability. Comparative mechanical properties of cable alloys quoted by Hack[25] are shown in Table IV.

Additions of small amounts of arsenic, tin, antimony, tellurium, silver and bismuth have also been used in cable-sheathing alloys with improvement in creep and fatigue properties.

TABLE IV—MECHANICAL PROPERTIES OF CABLE COVERING ALLOYS

	Tensile Strength lb/in^2	Elongation (per cent)	Fatigue Strength
Pure Lead	1,700	50	400
1 per cent Antimony-Lead	3,000	37	900-1,000
0·04 per cent Calcium-Lead	3,800-4,500	33	1,200-1,500

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(To be continued)

Galvanic Corrosion

IN an investigation into galvanic and electrolytic corrosion of plate-type galvanic couples, two magnesium-base alloys were coupled to seven aluminium alloys, mild steel, type 304 stainless steel (plain and chromium plated), red brass, and Monel. The first year of exposure showed that the seven aluminium alloys had the least galvanic corrosion when coupled to either of the magnesium-base alloys, although all the aluminium alloys were approximately equivalent in their galvanic effect on these magnesium alloys. There was no significant difference between galvanic corrosion caused by high-purity and commercial-purity aluminium alloys. The magnesium alloys suffered the severest galvanic corrosion when in contact with brass, Monel, mild steel, and stainless steel. The work was carried out under the auspices of ASTM B-3 on Corrosion of Non-Ferrous Metals and Alloys, the results being presented at the 64th annual meeting of the Society.

OUT OF THE MELTING POT

Wide Field HOPES of progress in applying vibration to cutting tools to facilitate turning, drilling, etc., must at once be tempered by the realization of the multiplication of the parameters brought about by the introduction of vibrations of the cutting tool as an additional variable. Taking a single-point turning tool, for example, matters can be complicated right from the start by the obvious possibility of arranging for the cutting tip to vibrate linearly in the direction of the feed (when a chip-breaking effect may be expected), in a direction tangential to the work (which should improve the machining process), or in several directions simultaneously. Even taking the first and simplest case of vibration in the direction of the feed, unavoidable factors which have to be taken into consideration include the amplitude of the vibrations and its relation to the forward feed of the tool per revolution of the work, and the frequency of vibration and its relation to the r.p.m. of the work. The first of these—vibration amplitude to feed ratio— is particularly significant in relation to the chip-breaking effect of the vibrating tool. The variation in the depth of cut brought about by the vibrations in the direction of the feed results in a periodic variation of the effective cutting angles, and may be expected to reduce the temperature in the cutting zone (a reduction of the order of 30 per cent has been shown to occur) and also the cutting force. This benefits tool life, counterbalancing any direct adverse effect, in this respect, of the vibrations. The chip-breaking effect also depends on the frequency of the vibrations being out-of-phase with the rotation of the work. Dimensional accuracy and surface quality should not be affected appreciably by vibratory machining under suitable conditions. Last, but not least, there remains the choice of the necessary vibratory tool supports — pneumatic, hydraulic, electro-hydraulic, etc., types, or a simple mechanical autovibratory type.

Separated Beta DISCUSSIONS of alpha-beta titanium alloys, of aluminium as a stabilizer of alpha-titanium, and of iron, chromium, molybdenum, vanadium and other metals as stabilizers of beta-titanium have been provided with useful evidence by a method for the electrolytic separation of beta-titanium. The method has been applied to an alpha-beta titanium alloy containing 4·9 per cent aluminium, 1·38 per cent molybdenum, 1·90 per cent chromium, 0·13 per cent silicon, 0·1 per cent iron, and 0·05 per cent carbon, with titanium forming the remainder. By connecting a sample of the alloy to the positive terminal of a D.C. supply and electrolysing with a current density of 0·07 amp/cm^2 in a solution of 50 mL hydrochloric acid (specific gravity 1·19) in 1,000 mL of methyl alcohol at room temperature, the beta-phase of the alloy can be recovered in the pure state as a residue after dissolution of the alpha-phase. This residue is filtered off, washed with alcohol and dried in a vacuum oven at 50-60°C. Its identity as the beta-phase (beta-titanium stabilized by molybdenum and chromium) is confirmed by X-ray and electron diffraction examination. Chemical analysis showed that it was enriched in molybdenum and chromium as compared with the over-all contents of these elements in the alloy. In conformity with the known insolubility of aluminium in beta-titanium, the recovered beta-phase did not contain aluminium. All the aluminium was found to have passed into solution in the electrolyte, which also contained some molybdenum and chromium. The results of the analyses did not balance fully because of the loss of some titanium during electrolysis as a result of the formation of the volatile titanium alcoholate.

Composition and Properties COMPLAINTS of coarse grain size and consequent cracking during blanking of copper - chromium alloy strip led to an extensive investigation of the effects of composition, and of rolling and heat-treatment on various properties of these alloys. Generally speaking, it is probably true to say that, by contrast with some other alloys, the effects of deformation and heat-treatment of copper-chromium alloys proved to be just as marked as the effects of composition. As regards the latter, chromium ranged from 0·54 per cent, through 0·66 per cent, to 0·79 per cent for the three alloys investigated. Whereas all three alloys had a fine-grained structure after hot rolling, the grain size after quenching from 800-1,000°C. depended on the chromium content and the quenching temperature: the lower the chromium content, the lower the temperature at which a coarse grain size developed. The increase in hardness on cold rolling of the quenched material reached a maximum after 50 per cent deformation and remained substantially unchanged by further deformation up to 70 per cent. Precipitation heat-treatment at 350° to 500°C. of the alloys after cold rolling showed that maximum hardness was obtained after quenching from 1,000°C. and precipitation heat-treatment at 400-450°C. Hardness increased with the degree of cold working. In certain circumstances, the alloy with the highest chromium content was liable to exhibit an anomalous behaviour, probably as a result of the formation of the solid solution being hampered by the relatively large size of the grains of the chromium phase. Regardless of the chromium content, the tensile strength, at 600°C., was found to depend on the quenching temperature, the maximum strength being obtained with an alloy quenched from 1,000°C., cold reduced 70 per cent and age-hardened at 400°C. The electrical conductivity of the alloys was likewise independent of the chromium content. There was a slight improvement on reducing the quenching temperature from 1,000° to 900°C. After precipitation heat-treatment, a conductivity greater than 75 per cent of that of copper could be developed.

Skinner

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Counter-flow Rinses

The use of a counterflow rinse is the most effective method of increasing the efficiency of the rinsing stage or, alternatively, of reducing the water requirement. As indicated in Fig. 1, the system consists of two or more swill tanks in line with the water flow and counter to the work flow. The articles from the process tank enter first the swill containing the more contaminated water; this removes the majority of the liquid carry-over. The work is then transferred to the second tank of clean water, where final rinsing takes place.

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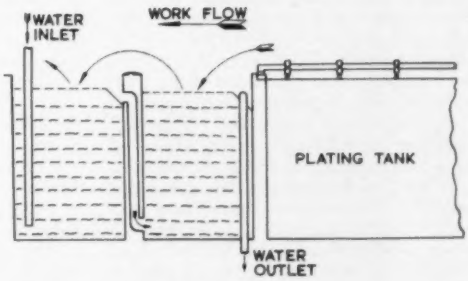
The usual practice is to replace the "drag-out" solution with fresh water at intervals, either daily or weekly, depending upon conditions, and to treat the discharge in small batches. This arrangement permits the use of simple and relatively inexpensive effluent treatment plant and, provided the system is carefully maintained, the running water discharges can often be kept sufficiently pure to be acceptable



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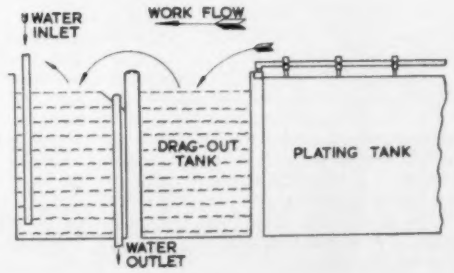

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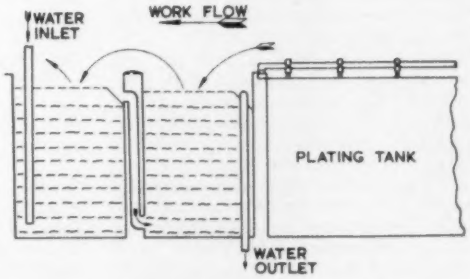

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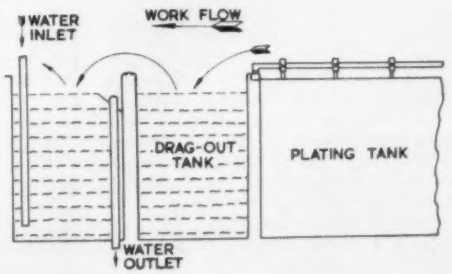


Fig. 2—Drag-out tank with running swill tank

by many local authorities for direct discharge to the sewer.

A modification of the "drag-out" is the use of a slow water flow. This avoids the necessity for the periodic emptying and refilling of the drag-out tanks while at the same time keeping the volume of effluent requiring treatment sufficiently small to permit simple batch treatment.

Other Aids

A further method of improving the effectiveness of the swills, which is particularly suitable for use on automatic plating plant, is the use of water sprays. These can be arranged as separate stages or may be fitted as top sprays over ordinary running swills. Automatic control is generally fitted so that the sprays come into action as the jigs of work enter or leave the swill tank; water consumption can thus be kept to a minimum.

Air agitation of the water swill may often be advantageous, particularly where the immersion time is short, where there is no movement of the articles whilst in the swill, or where viscous solutions are to be removed.

On manual plants, where the swill tanks may be out of use for considerable periods between loads of work, a considerable saving in water can be achieved by the use of conductivity control. The electrical conductivity of the water in a swill is an indication of the concentration of contamination (plating solution, etc.) present.

Electronic units are available which automatically turn on the water supply to the swill when the conductivity is high and cut off the water when sufficient has flowed to reduce the conductivity to a preselected low value. The use of the system enables high water flows to be used when work is passing through the swill, and avoids waste of water when the swill is out of use.

Australian Zinc and Lead

EXTENSIONS AT COCKLE CREEK INCLUDE NEW SINTER PLANT AND BLAST FURNACE

SULPHURIC acid and superphosphates have long been produced at the Cockle Creek plant of the Sulphide Corporation, a major Australian constituent of the British Consolidated Zinc Group. Now a new smelter will produce zinc and lead metals, and extensions costing some A£8 million have been completed enabling the company to meet the anticipated increase in the demand for acid and superphosphate during the next few years.

The new extensions consist of a sinter plant and zinc blast furnace (which can simultaneously produce lead bullion) and an acid plant capable of producing 250 tons of acid a day. Approximately 40,000 tons of zinc will be turned out annually from the smelter, which can produce a similar quantity of lead if required. This will increase Australia's overall zinc-lead smelting capacity by about 40 per cent.

When work began on the extensions in 1959, 82,000 tons of sulphuric acid and 134,000 tons of superphosphate were produced at Cockle Creek. Acid production capacity will rise to 130,000 tons annually when the plant is completely operating, and superphosphate production will increase to approximately 250,000 tons a year.

The company will now be able to use Australian sulphur-bearing materials in the bulk of its processing of zinc and lead concentrates from Broken Hill and pyrites concentrates from Lake George in New South Wales and Mount Morgan in Queensland.

The operations are complex, but reduced to their simplest forms they may be described as:—

(1) Sulphur-bearing zinc and lead concentrates are roasted in the huge sinter plant to produce sulphur dioxide gas and zinc lead sinter.

(2) The gas is piped into the contact plant, where it goes through several stages of treatment before it is eventually converted to sulphuric acid.

(3) Meanwhile, the zinc-lead sinter is treated in the blast furnace to produce metal.

Centrepiece of the site is the sinter plant, 125 ft. high and 350 ft. long. The main installation is the new Imperial smelting-type blast furnace developed by associated companies of the Sulphide Corporation in England. The design was carried out by another associated company in Melbourne, working in collaboration with the Corporation's Cockle Creek staff and the English associates. The plant has an operating temperature of 1,200°C.

The acid plant, which has a yearly output capacity of 88,000 tons, commenced operations in November 1960. It will not be working to full capacity of 250 tons daily until the plant and furnace near their top outputs.

Brimstone sulphur from deposits around the Gulf of Mexico were used till sulphur dioxide gas from the sinter plant was available for sulphuric acid production. Using this gas, the company will be able to curtail its imports of approximately 20,000 tons of brimstone sulphur.

When the new sulphuric acid production plant began operations, the older sections of the plant, built in the period 1913 to 1942, were closed down. Supplementing the new acid plant is one installed in 1955. It uses gas produced from iron pyrites, which is treated in a turbulent layer roaster plant. This plant has an annual capacity of about 130,000 tons of sulphuric acid a year.

About two-thirds of the present acid production is used for the production of superphosphate. The remainder is sold to local industries.

The increase in production will meet the growing demand for superphosphate in New South Wales, which is supplied by Sulphide Corporation and Australian Fertilizers Ltd., at Port Kembla.

Completely integrated, the furnace, sinter plant, sulphuric acid plant, and charge preparation and proportioning plants are all controlled from four control panels. Plant operators direct the basic operations of the works from air-conditioned control rooms, with the processes working continuously.

An adjunct of the main plant is a cadmium processing plant. The zinc concentrates contain a very small percentage of cadmium, which is recovered from the sinter plant in the form of an oxide, then processed into pure metal.

The cadmium plant has a capacity of 80 tons of metal a year.

The Cockle Creek plant was originally established in 1896 and was the first major industry in the Newcastle area of New South Wales. It was built to treat zinc ores, then developed into a lead smelter and refinery for treating lead, silver and gold-bearing ores from Broken Hill. Smelting ceased in 1922. Sulphuric acid and superphosphate production began in 1913, since when output has been increased progressively by additions and replacements of plant.

Industrial News *Home and Overseas*

Rolling Mill Practice

A Symposium on Modern Rolling Mill Practice is being sponsored by the **Institution of Plant Engineers,** to be held in Sheffield during April next year. The engineering implications in the design, control and servicing of rolling mill plant are such that the Institution feels there is a need at this time for the exchange of up-to-date knowledge so that members and non-members alike may be made aware of the latest information on the subject. One of the Papers to be presented will include a description of a new mill for the rolling of thin tinplate materials.

The Symposium will consist of three Papers presented by recognized authorities and will take place in the Engineering Lecture Theatre of the University of Sheffield.

The three Papers to be presented will be entitled: (a) "Developments in the Design of Rolling Mills"; (b) "Modern Control Techniques for Rolling Mills"; and (c) "Modern Techniques for Servicing Rolling Mills". The fee for this event (including one set of preprints, afternoon and buffet tea) will be two guineas. Those wishing to attend should make early application for registration forms to the Secretary of the Institution at 2 Grosvenor Gardens, London, S.W.1.

Hydraulic Press Order from France

News from the **Loewy Engineering Company Ltd.** is that they have received an order from France, valued at over £100,000, for a 1,200-ton oil-hydraulic free-forging press. This press will be capable of working at high speeds to extremely accurate limits, and is equipped with electronic thickness control. It will also be integrated with a rail-bound manipulator. This plant is one of five free-forging installations from 600 to 4,000 tons capacity with a total value of over £750,000 at present on order with Loewy.

Soviet Welding Equipment

On behalf of the **Owen Organization,** Sir Alfred Owen, C.B.E., has signed an agreement with V/O "Machinoeport" of Moscow for the distribution of a very wide range of Soviet welding equipment in most countries of the Commonwealth and the U.S.A.

It is understood that this agreement originated during the holding of the British Trade Fair in Moscow and the Soviet Exhibition in London recently. The company has made considerable progress in its efforts to increase East-West trade, and the conclusion of the agreement regarding welding equipment is part of the company's programme under discussion with the Soviet authorities at the present time.

A Vacation Course

It has been announced by the Metallurgy Department of the **Battersea College of Technology** that a vacation course on "Cathodic Protection—Instrumentation, Interference and Interference Testing" will be held on Tuesday and Wednesday, December 19 and 20 next, commencing at 9.30 each morning.

This course, which has been organized with the co-operation of the Corrosion Group of the Society of Chemical Industry, is intended for workers in the field of corrosion who are particularly interested in the problems associated with cathodic protection in practice. As the course will emphasize the instruments and their mode of application, particularly in interference testing, it will be assumed that members of the course will be familiar with the principles and practice of cathodic protection.

The fee for the course is £6, inclusive of luncheon, morning and afternoon refreshment. Enrolment forms may be obtained from the secretary, Battersea College of Technology, London, S.W.11.

An Anniversary Brochure

In October last, **J. Brockhouse and Company Ltd.,** the parent company of the Brockhouse Organization, reached its 75th anniversary. To mark the occasion the annual report and balance sheet is published in the form of a special 24-page, two-colour illustrated brochure which also records something of the company's background and achievements.

Founded by the present chairman's grandfather in 1886, with seven employees making cart and carriage springs, the organization is now a £7,500,000 concern comprising over 30 companies operating both at home and abroad.

Reversible Impactors

A range of Pennsylvania reversible impactors with capacities of up to 1,500 tons/hr. is now being manufactured at the Fraser and Chalmers works of **The General Electric Company (Engineering) Ltd.,** at Erith.

These crushers are the first of their type to be made in the United Kingdom and are stated to be particularly suitable for the refractory, metallurgical, lime, cement, gypsum and quarry industries. The main feature of this impactor is the reversible rotor. This means that with breaker blocks fitted on both sides of the machine and the feed chute placed directly over the centre of the rotor, the impactor operates when driven in either direction. By systematic reversal it is, therefore, possible to balance wear between the two sets of breaker blocks and between the two faces of each hammer.

New Safety Booklet

Precautions for the protection of factory workers and others against the potential hazards and dangers arising from the use of ionizing radiations in industry are discussed in "Ionising Radiations: Precautions for Industrial Workers", a new booklet in the Safety, Health and Welfare Series published by the Ministry of Labour, price 2s. 6d.

The booklet deals only with risks associated with the use of X-rays and sealed radioactive sources in industry, but risks associated with unsealed radioactive substances are mentioned incidentally where appropriate. It explains that the legal provisions for the protection of workers against ionizing radiations are made under the Ionising Radiations (Sealed Sources) Regulations, 1961, and gives general guidance on some of the principal requirements of these regulations.

An indication of some of the varied uses which industry makes of ionizing radiations and X-rays is also included. Among these are radiographic examinations in the ferrous and **non-ferrous metal** industries to discover faults, flaws, blowholes, cracks and the like in prototype or particularly important castings and forgings which are especially liable to high stress in use; the measuring and controlling of solids and liquids in bunkers and tanks; and the use of radioactive tracers to enable the mechanism of chemical, physical, engineering and biological processes to be followed and more fully understood.

Spanish Production

According to statistics issued by the Metal Syndicate in Madrid, Spanish production of lead in October totalled 6,574 tons, compared with 6,130 tons in September and 2,639 tons in October last year. This brought total production for the first 10 months of this year to 63,315 tons.

Production of zinc totalled 4,204 tons last September, compared with 3,306 tons in September and 2,840 tons in October 1960. Total output in the first 10 months of this year amounted to 30,599 tons.

Gold Bars

An announcement from **Johnson, Matthey and Company Ltd.** states that the London Gold Market added the name Metalli Preziosi S.p.A. of Milan to the list of acceptable melters and assayers. The Gold Market stated that bars produced by this company and bearing its stamp will in future be accepted as "good delivery" in London.

"Good delivery" gold bars can now be supplied by four companies of the Johnson, Matthey group in Europe and the Commonwealth; in addition to the London organization they are—Johnson, Matthey and Malloy Ltd., of Canada; Garrett, Davidson and Matthey Pty. Ltd., of Australia; and Metalli Preziosi S.p.A., of Milan.

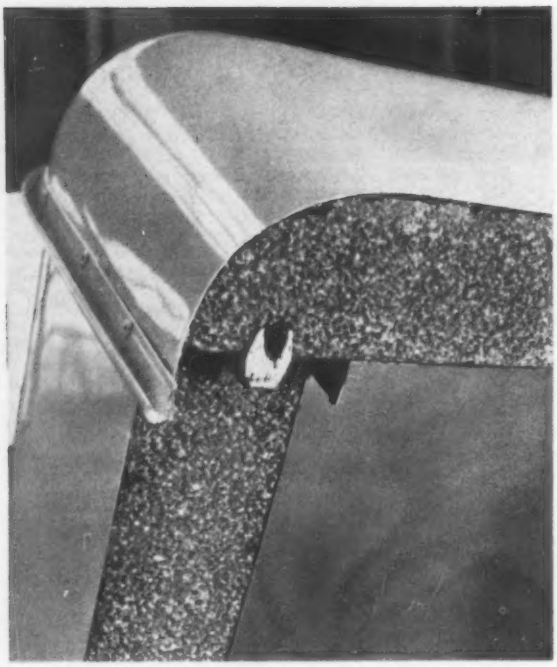
Cooling System for Furnaces

It has been reported that the Scottish firm of **Cochran and Company Annan Ltd.** has obtained the exclusive manufacturing rights in the United Kingdom for the Steinmuller system of evaporative cooling as applied to open hearth, reheating and other types of furnaces.

A Düsseldorf Meeting

On Thursday of last week, the eighth annual German tin conference was held in Düsseldorf. The **Tin Research Institute** was represented by Mr. W. R. Lewis and Dr. D. A. Robins, who read a Paper on "The Properties and Applications of Cast Iron Containing Tin".

Other Papers presented at this meeting were "A Review of Tin-base Bearing Alloys", by Mr. E. Roemer, of Wiesbaden, and "Development and Applications of 20 per cent Aluminium Bearings", by Mr. P. G. Forrester, of the Glacier Metal Company, Scotland.



A section of a refrigerated van body comprising rigid PVC foam glued with 'Araldite' between aluminium skins

Glued Construction

An interesting use of adhesives was shown at a display of insulated and refrigerated vehicles arranged by Mann Egerton and Co. Ltd., of Norwich, recently. A refrigerated body on a 30 cwt. Ford Trader consisted of a sandwich structure made by gluing 3½ in. thick slabs of Plasticell PVC foam between 20 gauge aluminium skins with "Araldite" epoxy resin.

This type of construction is stated to reduce the weight of the vehicle by 5 cwt., resulting in an increased payload. Also, assembly is quicker, leading to lower production costs.

New Orders

Orders valued at over £100,000 have been received by **Efco Furnaces Ltd.** for heat-treatment equipment to be installed in the new Rootes factory at Linwood, near Paisley, where the new small Hillman car is to be produced. The orders cover the supply of a battery of closed-quench furnaces, tempering and reheating furnaces, endothermic atmosphere generators with automatic dewpoint controllers, automatic temperature controllers and charge handling machinery. All the furnaces are to be electrically heated and the closed-quench furnaces will be fitted with corrtherm elements which were specially developed for use in carburizing atmospheres. Some of the closed-quench furnaces are to be used for carbonitriding gears and will have an enclosed hot-oil quench; others are to be used for gas carburizing pinions and crown wheels, and other engine parts.

In addition, Efco Furnaces Ltd. has received orders for furnaces for the treatment of aluminium die-cast components to be produced by Rootes in their die-casting factory, also being built at Linwood.

Tioxide Pigments

During the coming months, **British Titan Products Company Ltd.** propose to introduce new designs on the bags containing all grades of their Tioxide pigments. The company is issuing a card showing a typical design for both rutile and anatase grades. The introduction of bags carrying the new design will start grade by grade as the stock in the old bags is exhausted.

The company emphasizes the fact that this change relates solely to the design of the bags and that the quality of the pigment and their trade name are not involved at all.

Canadian-Swiss Aluminium

Aluminium Limited have announced that Diethelm and Company Limited, of Zurich, will participate as a minority shareholder in Alcan Malayan Aluminium Company Limited, the Canadian company's new fabricating subsidiary in Malaya. Earlier this year, Aluminium Limited announced the formation of Alcan Malayan to build an aluminium rolling mill in Malaya with a capacity of 2,000 tons per year, based on aluminium ingot imported from Canada. Construction is now under way at Petaling Jaya, near Kuala Lumpur. The estimated cost of the enterprise is 1·3 million dollars.

Welding Method

An extremely complex welding assignment—it takes the form of a fuel manifold assembly made up from nine lengths of $\frac{7}{8}$ in. O.D × 22 s.w.g. titanium into an approximate semicircle—is being undertaken by **Palmer Aero Products Limited,** a subsidiary of B.T.R. Industries Limited, with their recently developed Precision Orbital Welding Method. Sixteen welds are involved in each assembly and each weld is made in an inert atmosphere of argon.

This method is said to be of interest to all industries concerned with handling corrosive materials at elevated temperatures and allows a preformed tube to be automatically welded to an end fitting. The process is speedy, reliable and economical and supersedes conventional brazing methods.

Special Lecture Courses

In the forthcoming term of the **Borough Polytechnic,** London, the following special lecture courses have been arranged by the Division of Metal Science:—(a) Present-

MEN and Metals

After 26 years as a director of Monsanto Chemicals, **Sir William Garrett** has retired from the board of the company and **Mr. J. M. Kershaw** has been appointed to the board. Mr. Kershaw is the company's director of production, and joined the company in 1946 as a chemical engineer. He was appointed chief engineer in 1956 and director of production in 1960.

A director of Dowty Rotol and deputy managing director of Dowty Marine, **Mr. C. J. Wegerif** has been appointed sales director of Dowty Rotol.

Newly appointed directors of the Loewy Engineering Company Ltd. are **Mr. E. R. Henschker,** A.M.I.Mech.E., and **Mr. R. M. L. Elkan,** B.Sc., A.M.I.Mech.E. Mr. Henschker started with the company in 1937, becoming chief engineer of the rolling mill division in 1955. Mr. Elkan joined the company in 1947 and was later appointed assistant to the managing director of the hydraulic division.

It is announced that **Mr. V. F. F. Henley,** until recently with W. Canning and Company Limited, and formerly a director of Alumilite and Alzak Limited, has been appointed a director of Mitro Anodising Limited.

At the anniversary meeting of the Royal Society, held on Thursday of last week, the Hughes Medal was awarded to **Prof. A. H. Cottrell,** F.R.S., Goldsmiths' Professor of Metallurgy and Fellow of Christ's College, Cambridge University.

Deputy chairman and assistant managing director of Thos. W. Ward Limited, **Mr. Arnold Carr** has been appointed joint managing director of the company.

In a re-organization of their sales department, Thomas Bolton and Sons Limited have announced the following changes in their staff appointments:—**Mr. J. G. R. Warburton** will be transferred from Widnes to the Froghall works to take charge of the new sales department; **Mr. A. R. D. Kitson** to be London sales manager, both appointments to operate from January 1 next.

day methods of metal surface preparation —six lectures on consecutive Thursday evenings at 7 p.m., commencing on January 11, 1962; (b) corrosion testing—six lectures on consecutive Thursday evenings at 7 p.m., commencing on February 22, 1962, and (c) Modern developments in die-casting practice—four lectures on consecutive Wednesday evenings at 7 p.m., commencing on March 7, 1962.

All these lectures will be given by specialists in their subjects, and the fee for each course is 10s. Complete details of these courses may be obtained from the Division of Metal Science, Borough Polytechnic, Borough Road, London, S.E.1.

U.K. Metal Stocks

Stocks of refined tin in London Metal Exchange official warehouses at the end of last week fell 23 tons to 4,252 tons, comprising London 1,065, Liverpool 1,782, and Hull 1,405 tons.

Copper stocks rose 275 tons to 15,850 tons, distributed as follows: London 375, Liverpool 13,750, Birmingham 50, Manchester 1,400, Hull 250, and Glasgow 25 tons.

Lead duty-free stocks fell 274 tons to 7,734 tons, comprising London 7,184, Glasgow 300, Swansea 100, and Manchester 150 tons. In-bond stocks fell 160 tons to 3,260 tons, all in London.

Zinc duty-free stocks fell 140 tons to 8,079 tons, comprising London 2,398, Glasgow 31, Hull 325, Manchester 300, Liverpool 50, and Avonmouth 4,975 tons. In-bond stocks rose 259 tons to 3,132 tons, all in London.

Foundrymen's Meeting

At the London branch meeting of the **Institute of British Foundrymen,** to be held on Thursday next (December 14) at the National Liberal Club, in Whitehall Place, London, S.W.1, the branch are to be hosts to the London Local Section of the Institute of Metals.

The lecturer for the evening is Mr. E. C. Mantle, and his subject is to be "Feeding Non-Ferrous Castings". He will deal with the feeding of castings from the point of view of the constitution of the alloys, showing how feeders for one type of alloy are not necessarily suitable for alloys freezing in a different way. He will also mention the effect of grain refinement on feeding and running systems insofar as they affect the temperature gradients encouraging directional solidification of castings.

Tools Department Moves

It has been announced by **George Cohen Sons and Company Ltd.** that their engineers' tools department has moved from its old address at Bulwer Street, London, to the company's new machine tool headquarters at 23-25 Sunbeam Road, London, N.W.10. The telephone number is Elgar 7222.

This department carries a large stock of engineers' tools and fine measuring equipment. The counter service, which the department has always operated, will be continued from the new office.

Chemical Resistant Coatings

News from **Corrosion Technical Services Ltd.** (a subsidiary of John Mowlem and Company Limited) is that they have formed a new coatings division for the manufacture and application of chemical-resistant coatings and linings. The new division will undertake, both at their works and on site, the complete preparation (including shot-blasting) and application of linings and coatings to chemical plant, vessels, pipeworks and ducting.

The range of coatings includes solvent-free epoxy and polyester resins, aqueous P.V.C. and sprayed neoprene. The division will also handle the company's "Cortec" brand epoxy and polyester resin/glass laminated fabrications of tanks, pipework and ducting.

West German Production

According to official figures from Frankfurt, West Germany produced 14,834 tons of pig aluminium in October. September production amounted to 14,573 tons. Pure aluminium production totalled 1,515 tons (provisional) against 1,355 tons in September, and aluminium alloy production 10,291 tons, against 10,203 tons.

Production of refined copper from smelters amounted to 19,626 tons (provisional) against 20,058 tons in September, and from refineries out of scrap and crude copper 5,882 tons against 6,057 tons. Production of copper alloys was 3,256 tons, against 3,359 tons in September.

Semi-manufactured production from aluminium and aluminium alloys in October totalled 19,301 tons (provisional) against 18,723 tons, and from copper and copper alloys 53,043 tons, against 52,061 tons.

A Removal

It is learned from the **Distillers Company Limited** that their engineering division, until recently at Devonshire House, Piccadilly, has now been transferred to a new building, Enford House, 139-151 Marylebone Road, London, N.W.1. Every provision has been made to combine efficient working conditions with economy of space.

Scrap Merchants Meet

Birmingham was the venue on Tuesday this week for the half-yearly general meeting of the **National Association of Non-Ferrous Scrap Metal Merchants.** The meeting was held at the Midland Hotel under the chairmanship of Mr. A. G. Robinson, President of the Association. In the course of his report the President stated that the Council had held five meetings since June — three in London, one in Liverpool and the other in Birmingham. During the past six months five firms have been elected to membership, but there have been four resignations.

The Association, in conjunction with the Association of Light Alloy Refiners and Smelters Ltd., has agreed to the recent changes in aircraft specifications which made it necessary to amend the Standard Classifications and Segregation Schedule for Aluminium and Aluminium Alloy Scrap issued in September last year.

The President also referred to the works visits which were organized in Liverpool at British Insulated Callender's Cables Ltd. and Yorkshire Imperial Metals Ltd., both of which were most successful and much appreciated by all who attended. Negotiations are already in hand to organize similar visits in the Spring of next year.

Welding News

A new series of five spot-welding electrodes produced from $\frac{1}{2}$ in. diameter bar with $\frac{1}{2}$ in. tapers to B.S. 807, has been introduced by **Johnson, Matthey and Co. Ltd.** These electrodes are said to give better access in confined spaces and cost less than types made from $\frac{1}{4}$ in. bar. High-conductivity Mallory 3 alloy, one of the most versatile welding materials available, is used for the electrodes. The tapers are

Forthcoming Meetings

December 11 — Institute of Metals.— Scottish Local Section. Institution of Engineers and Shipbuilders, Elmbank Crescent, Glasgow, C.2. "Progress in the Electron Theory of Metals." J. A. Catterall. 6 p.m.

December 11—Institute of Metal Finishing. London Branch. Northampton College of Technology, St. John Street, London, E.C.1. "Practical Nickel Plating—An Open Forum." 6.15 p.m.

December 12 — Institute of Metals. South Wales Local Section. Metallurgy Department, University College, Swansea. "Some Theoretical Aspects of the Sintering of Metal Powders." G. A. Greach. 6.30 p.m.

December 12—Institute of Metals. Oxford Local Section. Cadena Café, Cornmarket Street, Oxford. "Lattice Spacing Determination as a Tool in Metallurgical Research." Prof. G. V. Raynor. 7.15 p.m.

December 12—Non-Ferrous Club. Ambassador Club, 38 Augustus Road, Edgbaston, Birmingham, 15. Luncheon Meeting. Speaker, P. Smith. 12.30 p.m.

December 12 — Institution of Works Managers. Birmingham Branch. College of Technology, Gosta Green, Birmingham. "How Sound is Our Economy?" A. L. Minkes. 7 p.m.

December 12—Institution of Production Engineers. Doncaster Branch. Technical College, Waterdale, Doncaster. "Continuous Casting." G. Littlewood. 7 p.m.

December 13 — Institution of Plant Engineers. Western Branch. Grand Hotel, Broad Street, Bristol. "Safety in Factories." J. B. Taylor. 7.15 p.m.

December 13—Institute of Metal Finishing. Organic Finishing Group. British Institute of Management, 80 Fetter Lane, London, E.C.4. "What the Paint User Wants to Know About Solvents." L. M. Barakan. 6.30 p.m.

December 14 — Institute of Metals. London Local Section. National Liberal Club, Whitehall Place, London, S.W.1. "Feeding Non-Ferrous Metals Castings." E. C. Mantle. 7 p.m.

December 14 — Institute of Metals. Sheffield Local Section. Applied Science Building, University of Sheffield. "Metals in the Jewellery Industry." Miss D. L. Pile. 7.30 p.m.

December 14 — Southampton Metallurgical Society. Southampton University. "Fatigue." T. R. G. Williams. 7.15 p.m.

accurately machined, and the recommended tip diameter and rake angle are provided. In accordance with the specification, the omission of spanner flats permits a larger diameter hole for cooling water.

The company has also introduced a new resistance welding electrode alloy, Mallory 328. Developed from long-established Mallory 3, the new alloy has an equally high electrical conductivity with slightly greater hardness at room temperature. The outstanding characteristics of Mallory 328 are its far better retention of strength and hardness at higher working temperatures, its superior elongation, and its greater resistance to cracking under severe welding conditions. These factors make it an excellent electrode material for welding all types of steel, especially coated steels.

Corrosion Prevention

On Wednesday, December 20 next, a meeting of the Corrosion Group of the **Society of Chemical Industry** is to be held at 14 Belgrave Square, London, S.W.1, at 6 p.m., for a discussion of two Papers recently published. These Papers are: "Experimental Survey of Rust Preventives in Water" and "Corrosion of Metals by Acid Vapours from Wood".

West German Aluminium

Consumer purchases of aluminium in West Germany this year are likely to decline to 415,000 tons against 429,000 tons in 1960, according to preliminary estimates released in Düsseldorf. In 1959, however, they totalled only 337,000 tons.

The substantial increase in 1960 purchases, as well as the prospective decline this year, are largely attributable to movements of stocks. Actual consumption in 1960 probably did not rise by 27 per cent as the statistics appear to indicate, but only by the same amount as the production of capital goods, some 16 per cent. As delays in delivery were cut this year, stocks have been run down.

The decline in demand affects mainly virgin aluminium, consumption of which is expected to fall to 290,000 tons this year, compared with 304,000 tons in 1960. Secondary aluminium consumption is expected to remain unchanged at 125,000 tons. Even so, production of virgin aluminium is expected to reach 173,000 tons this year compared with 169,000 tons last year. Aluminium imports, including alloys, are likely to decline to 138,000 tons this year from 181,000 in 1960. Virgin aluminium stocks, which at the end of 1960 amounted to 54,000 tons, will probably stand at 62,000 tons at the end of this year.

News from Birmingham

It was reported to the monthly meeting of the Midland Regional Board for Industry in Birmingham last week that the general rate of production still tended to slacken. The chairman, Major C. R. Dibben said that order books were shortening, profit margins were narrowing and the supply of labour was easier. The gradual slackening of momentum, he said had induced an increasingly cautious outlook in Midland industry, but closer examination showed that not all industries were equally affected. The Board agreed that demand from both home and foreign markets could reasonably be expected to expand in the spring. Activity remained at a reasonable level in general engineering, though below the peak established earlier in the year. The machine tool industry was still busy and so were the building and civil engineering industries.

No sign of recovery is noticeable in iron and steel, and metal-producing and metal-working firms have spare capacity. Steel output is around 70 per cent capacity. Although sheet production has been trimmed to meet smaller requirements of the motor trade it is still more than sufficient for current use. Structural steel remains the brightest spot in the picture, but the consumption tends to decline at this season of the year. Most of the ironfoundries could handle more work without difficulty.

Company Reports

Midland Aluminium

Group net profit, year to June 30, 1961, £117,709 (£131,550) and dividend 15 per cent (same). Fixed assets £788,377 (£603,265 and expenditure on Wombourn premises £246,000). Trade investments £183,256 (£225,956). Current assets £1,556,092 (£1,245,835), including cash £20,568 (£38,293); liabilities £925,623 (£731,500), including overdrafts £168,120 (£129,694). Commitments £20,000 (£51,000).

Metal Traders Ltd.

Group net profit, year to March 31, 1961, £86,299 (£108,561) and dividend 6d. per 2s. share (1s. including 3d. bonus). Current assets £4,844,308 (£4,478,890) and liabilities £3,841,823 (£3,389,080).

Wallis Tin Stamping

It is reported that the directors of the Wallis Tin Stamping Company have agreed terms with the Metal Box Company on which the latter company will offer to acquire the £223,750 capital of Wallis. The terms are said to be one 7 per cent Preference £1 share and two 4 per cent Second Preference £1 shares of Metal Box for every five 6 per cent Preference 10s. shares of Wallis, and one Ordinary £1 share of Metal Box for every five Ordinary 2s. shares of Wallis. It is expected that the formal offer will be circulated to shareholders before the end of this present month.

Reynolds International

News from Bermuda is to the effect that agreement has been reached for Reynolds International Incorporated, Hamilton, Bermuda, to acquire Aluminum Extruders Limited, a Canadian aluminium fabricating firm. The acquisition of Aluminum Extruders, a wholly owned subsidiary of the Kruger Organization Limited, Montreal, became effective on Monday last, December 4. Mr. J. Louis Reynolds, chairman of Reynolds International, said—"having been long associated with the Canadian aluminium industry, we know how it has succeeded in advancing the usage of aluminium. In 1960, Canada used 13 lb. of aluminium per person. We hope to help the Canadian industry's efforts to raise consumption of aluminium up to the level of U.S. consumption, which was 23 lb. per person in 1960."

Foundry Equipment and L and Y

Group net loss year to March 31, 1961, £39,367 (net profit £18,351), and no Ordinary dividend (5 per cent). Fixed assets £424,228 (£388,396). Current assets £659,601 (£587,285), liabilities £580,418 (£440,320), including overdrafts £286,597 (£257,337) and short-term loan £33,279 (nil).

New Companies

The particulars of companies recently registered are quoted from the daily register compiled by Jordan and Sons Limited, Company Registration Agents, Chancery Lane, W.C.2.

E. Jones (Feltham) Limited (706262), 1 Rowland Avenue, Kenton, Harrow, Middx. Registered October 23, 1961. To carry on business of electroplaters, etc. Nominal capital, £100 in £1 shares. Director: David G. Brodie.

N. P. Daisley Limited (706376), Works Road, Letchworth. Registered October 25, 1961. To carry on business of machinery and metal merchants, etc. Nominal capital, £3,000 in £1 shares. Directors: Neville P. Daisley and Margaret C. Daisley.

J. C. Crossland and Sons Limited (706656), Crusoe Foundry, Foundry Street, Parkgate, near Rotherham, Yorks. Registered October 27, 1961. To carry on business of ironfounders, brassfounders, metallurgists, etc. Nominal capital, £15,000 in £1 shares. Directors: James C. Crossland and Mrs. Winifred M. Crossland.

Leema Limited (706943), 70 Hayes Lane, Lye, Stourbridge, Worcs. Registered October 31, 1961. To carry on business of manufacturers of and dealers in pressings, forgings, etc. Nominal capital, £10,000 in £1 shares (5,000 red. cum. pref.). Directors: Ernest Humphries and Eliza Humphries.

Anglesey Copper Mines (U.K.) Limited (706999), 37 Norfolk Street, W.C.2. Registered November 1, 1961. Nominal capital, £2,000 in £1 shares. Directors: Riou Benson and John G. Patten.

Alfred Sargent (Polishers) Limited (707140), 405 Farm Street, Hockley, Birmingham, 19. Registered November 2, 1961. To carry on business of polishers, chromium and electro platers, etc. Nominal capital, £5,000 in £1 shares. Directors: Alfred T. Sargent and Ada E. Sargent.

Braemar Metal Company Limited (707168), 54 Gamage Building, 118-122 Holborn, E.C.1. Registered November 2, 1961. Nominal capital, £100 in £1 shares. Directors: Joseph Van Praag and Harry Van Praag.

Deansfield Plating Company Limited (707198), Colliery Road, Wolverhampton. Registered November 3, 1961. Nominal capital, £500 in £1 shares. Directors: Alfred Clifford and Reuben Clifford.

Walters' Brass Works Limited (707223), Craven Street, Burnley. Registered November 3, 1961. Nominal capital, £5,000 in £1 shares. Directors: Wilfred Walters and Alice Walters.

Metal Market News

EVENTS on the Metal Exchange last week, and the trend of prices, typified the period of the year, with its near approach of the holidays and the somewhat sluggish spirit that supervenes when the year end approaches. On balance, values were a little lower but there was virtually nothing in it and, as will be seen from the details shown below, zinc was an exception and showed an advance on the week. For the first time for some weeks, copper stocks in official L.M.E. warehouses registered a gain, being up by 486 tons to 15,625 tons. This has been taken to mean that the special operation of withdrawing stocks for conversion into electro has, temporarily at any rate, come to an end, but it is, of course, quite on the cards that the plan will again be put into operation. As to the other metals, L.M.E. warehouse stocks of tin fell by 71 tons to 4,275 tons, while the reserves of lead and zinc were lower by 191 tons to 11,428 for lead, and 65 tons to 11,092 tons for zinc. On the Metal Exchange, dealing was well maintained and the turnover about average, but copper had one or two really good days when the tonnage changing hands exceeded 3,000 tons.

In copper, it is probably true to say that business last week showed some small improvement inasmuch as consumers were inclined to put a certain amount of metal on their books, but confidence is still lacking. Some weeks ago, there was a feeling in some quarters that a backwardation in copper would probably be seen in the new year, but it must be admitted that at the moment there is little or no sign of this, for more often than not the market is level at the present time. Once again reports from Chilean centres of production have suggested that serious labour troubles might develop again at the end of the year, but this news did little or nothing to help the market. The fact is that there is a fairly strong feeling that curtailment of output is virtually dead and it must be confessed that there is little or no evidence of any scarcity of supplies in any direction. Price movement on the U.S. futures market have followed fairly closely the trend in London, but it must, at the same time, be admitted that when Comex scores an advance the influence of this movement is felt in Whittington Avenue.

Zinc improved in value last week quite conspicuously and closed at the highest point, viz. £72 for cash and £73 three months. The turnover was above average at 12,500 tons and the prompt position scored an advance of £1 17s. 6d., while the forward quotation went up by £1 15s. 0d. Influential buying certainly had an effect on the price last Friday. Whether the rise can be maintained remains to be seen. In lead, some 7,700 tons changed hands and the course of the quotation was rather erratic but, on balance, values at the close were lower than the previous Friday's prices by 7s. 6d. and 12s. 6d. The Canadian price was increased by ¼ cent. Some 12,000 tons of copper changed hands on a market registering minor day-to-day fluctuations. At the close, cash was 10s. down at £228 10s. 0d. and forward 5s. off at £228 15s. 0d.

New York

At the week-end, copper futures were steady in fair dealings. In physical copper, conditions continued quiet. Dealers, custom smelters and producers noted little change in the recent pace of sales. One leading producer source said that notwithstanding the present quietness, reflecting mainly year-end inventory tax consideration, December sales should show a fair total. He said January business should be better and the price steady. Scrap copper was unchanged.

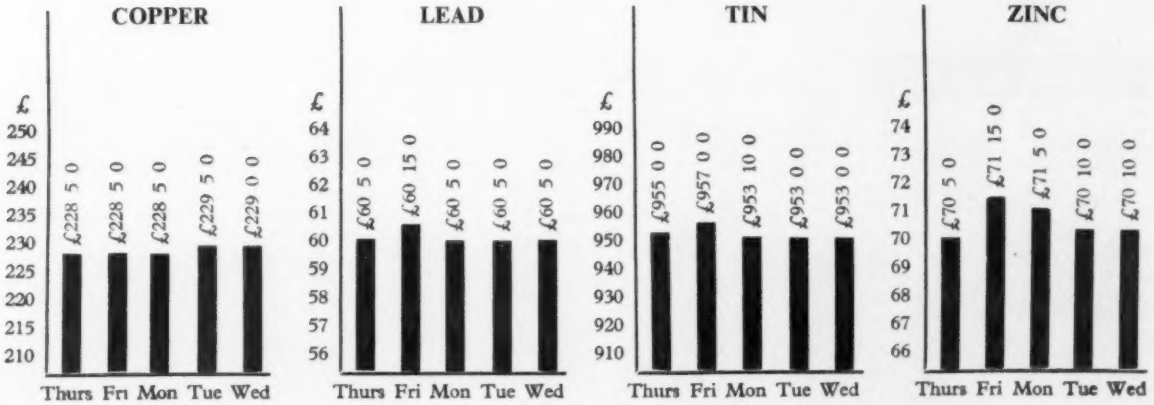
The zinc sales situation was somewhat confused. A number of major sellers have not advanced their price yet. The status of the special high grade zinc price being a leading factor, sellers are trying to eliminate the recently prevailing discount on special high grade sales and are hesitating in raising either the price of western or other grades until the pricing situation in special high grade zinc is clarified. Zinc sales were moderate, while lead was quiet. The American Smelting and Refining Company announced later that it was raising its prime western zinc price by ½ cent to 12 cents East St. Louis basis, but taking no action on high grade and special high grade prices.

Tin was steadier but quiet, aided by the advance abroad. Spot was offered at 122⅜ cents/lb., December and January at 122⅛, February at 122 and March at 121⅞ cents/lb.

The General Services Administration has announced the sale to Metal Traders, Incorporated, of New York, of 184·180 troy ounces of 99·90 per cent rhodium sponge and 100·9125 troy ounces of 99·90 per cent rhodium powder. G.S.A. received an average of 130 dollars 7 cents per ounce for the rhodium sponge and powder, a total return of 37,164 dollars, an agency spokesman said. Four companies submitted sealed bids to buy all the rhodium offered, he said. G.S.A. had been holding rhodium sales about every six weeks, but might decide to offer its remaining stock of 1,142 troy ounces instead at a rate of about 280 ounces each month, he added.

London Metal Exchange

Thursday 30 November to Wednesday 6 December 1961



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NON-FERROUS

PRIMARY METALS

All prices quoted are those available at 2 p.m. 6/12/61

		£	s.	d.
Aluminium Ingots	ton	186	0	0
Antimony 99·6%	,,	237	10	0
Antimony Metal 99%	,,	230	0	0
Antimony Oxide Commercial	,,	194	10	0
Antimony White Oxide	,,	212	0	0
Arsenic	,,	400	0	0
Bismuth 99·95%	lb.		16	0
Cadmium 99·9%	,,		11	6
Calcium	,,	2	0	0
Cerium 99%	,,	18	0	0
Chromium	,,		6	11
Cobalt	,,		12	0
Columbite	per unit		7	10
Copper H.C. Electro	ton	229	0	0
Fire Refined 99·70%	,,	228	0	0
Fire Refined 99·50%	,,	227	0	0

		£	s.	d.
Copper Sulphate	ton	78	0	0
Germanium	grm.		—	
Gold	oz.	12	9	8¼
Indium	,,		10	0
Iridium	,,	24	0	0
Lanthanum	grm.		15	0
Lead English	ton	60	5	0
Magnesium Ingots	lb.			
99·8%	,,		2	2½
99·9+%	,,		2	3
Notched Bar	,,		2	9½
Powder Grade 4	,,		5	6
Alloy Ingot. AZ91X		1	11½-2	1¼
Manganese Metal	ton	280	0	0
Mercury	flask	59	0	0
Molybdenum	lb.	1	15	0
Nickel	ton	660	0	0
F. Shot	lb.		5	11
F. Ingot	,,		5	11
Osmium	oz.	20	0	0
Osmiridium	,,		—	

		£	s.	d.
Palladium	oz.	9	0	0
Platinum	,,	30	5	0
Rhodium	,,	46	0	0
Ruthenium	,,	16	0	0
Selenium	lb.	2	1	0
Silicon 98%	ton	123	0	0
Silver Spot Bars	oz.		6	8
Tellurium Sticks	lb.	2	0	0
Tin	ton	953	0	0
***Zinc**				
Electrolytic	ton		—	
Min 99·99%	,,		—	
Virgin Min 98%	,,	71	0	0
Dust 95/97%	,,	112	0	0
Dust 98/99%	,,	118	0	0
Granulated 99+%	,,	96	0	0
Granulated 99·99+%	,,	107	8	9

**Duty and Carriage to customers' works for buyers' account.*

INGOT METALS

All prices quoted are those available at 2 p.m. 6/12/61

Aluminium Alloy (Virgin)	£	s.	d.
B.S. 1490 L.M.5 ton	nom.		
B.S. 1490 L.M.6 ,,	,,		
B.S. 1490 L.M.7 ,,	,,		
B.S. 1490 L.M.8 ,,	,,		
B.S. 1490 L.M.9 ,,	,,		
B.S. 1490 L.M.10 ,,	,,		
B.S. 1490 L.M.11 ,,	,,		
B.S. 1490 L.M.12 ,,	,,		
B.S. 1490 L.M.13 ,,	,,		
B.S. 1490 L.M.14 ,,	,,		
B.S. 1490 L.M.15 ,,	,,		
B.S. 1490 L.M.16 ,,	,,		
B.S. 1490 L.M.18 ,,	,,		
B.S. 1490 L.M.22 ,,	,,		
Aluminium Alloys (Secondary)			
B.S. 1490 L.M.1 ton	144	0	0
B.S. 1490 L.M.2 ,,	145	0	0
B.S. 1490 L.M.4 ,,	154	0	0
B.S. 1490 L.M.6 ,,	170	0	0
***Aluminium Bronze**			
BSS 1400 AB.1 ton	238	0	0
BSS 1400 AB.2 ,,	245	0	0

		£	s.	d.
***Brass**				
BSS 1400-B3 SCB2	ton	176	0	0
BSS 249	,,	172	0	0
***Gunmetal**				
B.S. 1400: LG2 d/d	,,	209	0	0
B.S. 1400: LG3 d/d	,,	219	0	0
B.S. 1400: GI 1½ Pb d/d	,,	278	0	0
B.S. 1400: GI ½ Pb d/d	,,	294	0	0
***Manganese Bronze**				
BSS 1400 HTB1	,,	195	0	0
BSS 1400 HTB2	,,	212	0	0
BSS 1400 HTB3	,,	226	0	0
Nickel Silver				
Casting Quality 12%	,,	255	0	0
,, ,, 16%	,,	265	0	0
,, ,, 18%	,,	310	0	0
***Phosphor Bronze**				
B.S.1400P.B.1.(A.I.D. released)	,,	312	0	0
B.S. 1400 L.P.B.1	,,	233	0	0

**Average prices for the last week-end.*

Phosphor Copper	£	s.	d.
10% ton	251	0	0
15% ,,	254	0	0
Phosphor Tin			
5% ,,	1030	0	0
Silicon Bronze			
BSS 1400-SB1 ,,	275	0	0
Solder, soft, BSS 219			
Grade C Tinmans ,,	424	0	0
Grade D Plumbers ,,	334	15	0
Grade M ,,	468	10	0
Solder, Brazing, BSS 1845			
Type 8 (Granulated) lb.		—	
Type 9 ,,		—	
Zinc Alloys			
BSS 1004 Alloy A ton	100	18	9
BSS 1004 Alloy B ,,	104	18	9
Sodium-Zinc lb.		2	6

SCRAP METALS

Merchants' average buying prices delivered, per ton, 5/12/61

Aluminium	£
New Cuttings	134
Old Rolled	97
Segregated Turnings	72
Brass	
Cuttings	154
Rod Ends	141
Heavy Yellow	131
Light	126
Rolled	142
Collected Scrap	128
Turnings	133

Copper	£
Wire	204
Firebox, cut up	202
Heavy	196
Light	191
Cuttings	207
Turnings	193
Braziery	161
Gunmetal	£
Gear Wheels	196
Admiralty	196
Commercial	175
Turnings	170

Lead	£
Scrap	49
Nickel	
Cuttings	—
Anodes	590
Phosphor Bronze	
Scrap	175
Turnings	170
Zinc	
Remelted	62
Cuttings	47
Old Zinc	30

METAL PRICES

SEMI-FABRICATED PRODUCTS

Prices vary according to dimensions and quantities. The following are the basic prices for certain specific products

	£	s.	d.
Aluminium			
Sheet 10 S.W.G. lb.		2	10½
Sheet 18 S.W.G. ,,		3	0½
Sheet 24 S.W.G. ,,		3	3½
Strip 10 S.W.G. ,,		2	10½
Strip 18 S.W.G. ,,		2	11½
Strip 24 S.W.G. ,,		3	1
Circles 22 S.W.G. ,,		3	4½
Circles 18 S.W.G. ,,		3	3½
Circles 12 S.W.G. ,,		3	2½
Plate as rolled ,,		2	10
Sections ,,		3	4
Wire 10 S.W.G. ,,		3	1½
Tubes 1 in. o.d. 16 S.W.G. ,,		4	4
Aluminium Alloys			
BS 1470. HS19W.			
Sheet 10 S.W.G. ,,		3	3
Sheet 18 S.W.G. ,,		3	5½
Sheet 24 S.W.G. ,,		4	1
Strip 10 S.W.G. ,,		3	3
Strip 18 S.W.G. ,,		3	4½
Strip 24 S.W.G. ,,		4	0½
BS1477. HP30M.			
Plate as rolled ,,		3	1
BS1470. HC15WP.			
Sheet 10 S.W.G. ,,		4	3
Sheet 18 S.W.G. ,,		4	8½
Sheet 24 S.W.G. ,,		5	8½
Strip 10 S.W.G. ,,		4	4
Strip 18 S.W.G. ,,		4	8½
Strip 24 S.W.G. ,,		5	4½

	£	s.	d.
Aluminium Alloys—cont.			
BS1477. HPC15WP.			
Plate heat treated .... lb.		3	10½
BS1475. HG19W.			
Wire 10 S.W.G. ,,		4	2
BS1471. HT19WP.			
Tubes 1 in. o.d.			
16 S.W.G. ,,		5	5
BS1476. HE19WP.			
Sections ,,		3	4
Split tube			
19 S.W.G. (⅛″) ,,		4	2
20 S.W.G. (⅛″) ,,		3	11
21 S.W.G. (⅛″) ,,		4	1
22 S.W.G. (¼″) ,,		4	11
Welded tube			
14 to 20 S.W.G. (sizes ½″ to 1½″) ,,		3/5½ to 5/5	
Brass			
Tubes lb.		1	9¾
Brazed Tubes ,,		3	1¾
Drawn Strip Sections ,,		3	1¾
Sheet ton	195	10	0
Strip ,,	195	10	0
Extruded Bar lb.		2	0
Condenser Plate (Yellow Metal) ton	184	0	0
Condenser Plate (Naval Brass) ,,	198	0	0
Wire lb.		2	8½

	£	s.	d.
Beryllium Copper			
Strip lb.	1	4	11
Rod ,,	1	1	6
Wire ,,	1	4	9
Copper			
Tubes lb.		2	3⅛
Sheet ton	262	10	0
Strip ,,	262	10	0
H.C. Wire ,,	280	5	0
Cupro Nickel			
Tubes 70/30 lb.		3	8¾
Lead			
Pipes (London) ton	102	10	0
Sheet (London) ,,	100	5	0
Tellurium Lead ,,	£6 extra		
Nickel Silver			
Sheet and Strip 10% lb.		3	11¾
Wire 10% ,,		4	4¾
Phosphor Bronze			
Wire ,,		4	2
Titanium (1,000 lb. lots			
Billet 4½″ to 18″ dia. lb.	47/-		48/-
Rod ½″ to 4″ dia. ,,	85/-		53/-
Wire ·036″·232″ dia. ,,	159/-		99/-
Strip ·001″ to ·048″ ,,	350/-		68/-
Sheet 8′×2′. 20 gauge ,,	73/-		
Tube, representative average gauge ,,	198/-		
Extrusions ,,	90/-		
Zinc			
Sheet ton	108	5	0
Strip ,,	nom.		

FOREIGN QUOTATIONS

Latest available quotations for non-ferrous metals with approximate sterling equivalents based on current exchange rates

Belgium	fr/kg	£/ton
Copper: electrolytic	31.75	232 1
Tin	134.20	980 17

Canada	c/lb	£/ton
Aluminium	24.00	194 8
Copper: electrolytic	30.00	243 0
Lead	10.00	81 0
Nickel	82.50	668 5
Zinc: Prime western	11.50	93 3
High grade 99.95	12.10	98 0
High grade 99.99	12.50	101 5

France	fr/kg	£/ton
Aluminium	2.43	179 11
Antimony 99·0	2.80	206 18
Cadmium	16.75	1,247 16
Copper: electrolytic	3.21	237 4
Lead	.90	66 10
Nickel	9.00	665 2
Tin	13.70	1,012 8
Zinc: Thermic	1.07	79 1
Zinc: electrolytic	1.15	85 0
Scrap		
Copper: electrolytic	2.85	210 12
Heavy copper	2.85	210 12
No. 1 copper wire	2.78	205 8
Brass rod ends	2.17	160 7
Zinc castings	.85	62 16
Lead	.82	60 11
Aluminium	1.80	133 0

Italy	lire/kg	£/ton
Aluminium	370	216 1
Antimony 99·0	470	274 9
Copper: wire bars 99·9	445	259 17
Lead	155	90 10
Nickel	1,300	805 14
Tin	1,840	1,074 11
Zinc: electrolytic	165	96 7
Scrap		
Aluminium soft sheet clippings (new)	290	169 7
Lead, soft, first quality	130	75 18
Lead, battery plates	74	43 4
Copper, first grade	370	216 1
Bronze, commercial gunmetal	420	245 7
Brass: heavy	270	157 13
Brass: light	255	148 18
Brass, bar turnings	265	154 15
Old zinc	93	54 6

Switzerland	fr/kg	£/ton
Aluminium	2.50	210 5
Copper: electrolytic	2.88	242 4
Lead	.80	67 5
Nickel	7.68	645 17
Tin	11.68	982 5
Zinc: High grade 99.99	.98	82 8

Japan	Yen per metric ton
Scrap	
Copper: electrolytic	268,000
Copper wire No. 1	240,000
Copper wire No. 2	225,000
Heavy copper	233,000
Light copper	213,000
Brass, new cuttings	175,000
Red brass scrap	215,000

West Germany *Scrap*	D-marks per 100 kilos	£/ton
Used copper wire	220	200 8
Heavy copper	220	200 8
Light copper	185	168 10
Heavy brass	150	136 13
Light brass	110	100 5
Soft lead	50	45 11
Zinc	48	43 14
Used aluminium unsorted	90	82 0

United States	c/lb	£ ton
Aluminium	24.00	191 5
Antimony 99·0	32.50	259 0
Cadmium	160.00	1,275 4
Copper: electrolytic	31.00	247 10
Lead	10.00	79 14
Nickel	82.34	656 4
Tin	123.00	980 6
Zinc: electrolytic	12.50	99 12

THE STOCK EXCHANGE

Little General Change

ISSUED CAPITAL *	AMOUNT OF SHARE	NAME OF COMPANY	MIDDLE PRICE 4 DECEMBER	+RISE—FALL	DIV. FOR LAST FIN. YEAR	DIV. FOR PREV. YEAR	DIV. YIELD	1961 HIGH	1961 LOW	1960 HIGH	1960 LOW
£	£				Per cent	Per cent					
4,435,792	1	Amalgamated Metal Corporation ...	29/9		11	9	7 8 0	33/9	26/3	35/-	26/6
400,000	2/-	Anti-Attrition Metal	1/3		NIL	4	NIL	1/3½	0/9	1/6	0/9
43,133,663	Stk. (£1)	Associated Electrical Industries ...	30/3	—1/-	15	15	9 18 3	54/10½	28/3	67/3	38/3
3,895,963	1	Birfield	65/3	+4/-	10	15‡	3 1 3	78/9	45/-	51/3	29/-
4,795,000	1	Birmid Industries	64/6		20	20	6 4 0	103/-	64/1½	74/9	56/-
8,445,516	Stk. (10/-)	Birmingham Small Arms	18/9		11½	11½K	6 4 6	36/10½	18/4½	30/6	18/3
203,150	Stk. (£1)	Ditto Cum. A. Pref. 5%	13/-		5	5	7 13 9	14/6	12/3	17/4½	14/9
476,420	Stk. (£1)	Ditto Cum. B. Pref. 6%	16/6		6	6	7 5 6	17/6	15/4½	20/-	17/1½
1,500,000	Stk. (£1)	British Aluminium Co. Pref. 6% ...	16/-		6	6	7 10 0	18/-	15/3	21/1½	17/7½
21,737,634	Stk. (£1)	British Insulated Callender's Cables	56/3		13½	13½	4 16 0	62/3	49/-	61/4½	47/-
30,683,348	5/-	British Oxygen Co. Ltd., Ord. ...	15/-	+9d.	16D	16	3 11 6	28/4½	14/-	35/-	19/10½
1,200 000	Stk (5/-)	Canning (W.) & Co.	15/7½	—4½d.	15½	25+*2½C‡	5 0 6	20/9	13/7½	19/9	13/7½
60,484	1/-	Carr (Chas.)	1/3	+1½d.	NIL	NIL	—	1/7½	10½d.	2/3	1/-
550 000	1	Clifford (Chas.) Ltd.	27/9	+3d.	12	10	8 13 0	31/-	26/-	35/-	28/9
45,000	1	Ditto Cum. Pref. 6%	15/-		6	6	8 0 0	15/3	15/-	16/-	15/10½
1,166,000	Stk. (2/-)	Clifford Components V	8/3	+3d.	25*2½C	25*2½C	6 1 3	10/1½	7/3	11/9	6/10½
300,000	2/-	Coley Metals	2/6	—3d.	15	15	12 0 0	4/5½	2/6	5/-	3/4½
10,185,696	1	Cons. Zinc Corp.†	48/-	—6d.	20 O	15	8 6 9P	81/6	48/-	80/9	59/6
5,399,056	5/-	Davy-Ashmore	30/6		27½	22½	4 10 3	44/6	29/-	147/3	99/6
8,995,011	5/-	Delta Metal	20/3	—3d.	20	17½	4 18 9	27/7½	19/-	28/3	18/6
5,296,550	Stk. (£1)	Enfield Rolling Mills Ltd.	36/-	+9d.	15	15	8 6 9	52/3	35/3	56/9	45/-
1,155,000	1	Evered & Co.	42/-		10	10ôB	4 15 3	45/9	42/-	42/9	29/3
18,000,000	Stk. (£1)	General Electric Co.	26/-		10	10	7 13 9	39/6	24/3	47/9	29/-
1,500,000	Stk. (10/-)	General Refractories Ltd.	47/9	+6d.	25	20	5 4 9	65/-	42/9	52/6	40/-
937,500	5/-	Glacier Metal Co. Ltd.	21/-	+1/6	15	13	3 11 0	21/1½	13/9	16/1½	11/1½
2,750,000	5/-	Glynwed Tubes	23/9	+3d.	22½	25¶	4 14 9	30/3	22/6	27/6	17/-
7,228,065	10/-	Goodlass Wall & Lead Industries ...	31/6		15	19L	4 15 3	44/9	28/-	41/9	33/-
696,780	10/-	Greenwood & Batley	16/-		15	30‡	9 7 6	29/6	14/3	33/6	29/1½
792 000	5/-	Harrison (B'ham) Ord.	8/6	—3d.	*10	*20‡	5 17 9	14/6	8/6	15/10½	11/9
150,000	1	Ditto Cum. Pref. 7%	18/3		7	7	7 13 6	20/4½	18/-	23/6	22/-
1,612,750	5/-	Heenan Group	14/-	+3d.	13	11½K	4 12 9	17/1½	10/6	13/-	9/10½
266,608,683	Stk. (£1)	Imperial Chemical Industries ...	58/-	—2/-	13½	11½	4 15 0	81/6	56/3	76/6	54/-
34,736,773	Stk. (£1)	Ditto Cum. Pref. 5%	14/3		5	5	7 0 3	16/-	13/10½	18/-	15/4½
29,196,118	**	International Nickel	142½	+7½	$1.60	$1.50	1 16 6	160	104	105	84½
6,000,000	1	Johnson, Matthey & Co.	82/6	+2/6	15	12	3 12 9	84/-	57/6	67/6	44/9
600,000	10/-	Keith, Blackman	17/-		17½	17½E	10 6 0	21/6	16/6	32/6	17/6
320,000	4/-	London Aluminium	10/-	—2/9	N	13	—	15/-	8/6	12/6	7/10½
2,667,542	1	McKechnie Bros. A Ord.	32/-		11½K	17½	7 8 0	53/3	31/3	69/3	55/-
1,108,268	5/-	Manganese Bronze & Brass	9/6		20½	20½	10 10 0	18/6	8/3	18/6	13/4½
50,628	6/-	Ditto (7½% N.C. Pref.)	5/-		7½	7½	9 0 0	6/-	5/-	6/6	5/9
26.361,444	Stk. (£1)	Metal Box	81/6		12	12M	2 18 9	100/9	68/3	84/3	61/-
415,760	Stk. (2/-)	Metal Traders	5/-		25	50H	10 0 0	8/9	5/-	10/9	7/1½
240,000	1	Mint (The) Birmingham	36/6		15G	12½	5 9 6	36/6	24/-	39/-	33/6
80,000	5	Ditto Pref. 6%	70/-		6	6	8 11 6	77/6	70/-	80/-	75/-
274,152	1/-	Minworth Metals	4/9		30	30S	6 6 3	6/3	4/6½	5/2½	3/10½
5,187,938	Stk. (£1)	Morgan Crucible A	59/3		14	13	4 14 6	71/3	53/4½	63/-	47/6
1,000,000	Stk. (£1)	Ditto 5½% Cum. 1st Pref. ...	15/6		5½	5½	7 2 0	17/-	13/10½	18/9	15/9
3,850,000	Stk. (£1)	Murex	40/3	+9d.	13	22½J	6 9 3	52/-	36/9	45/-	35/3
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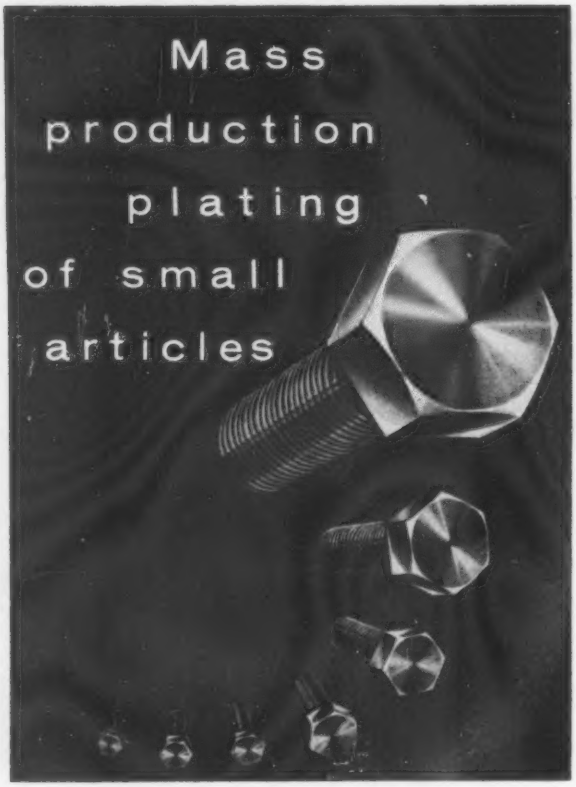

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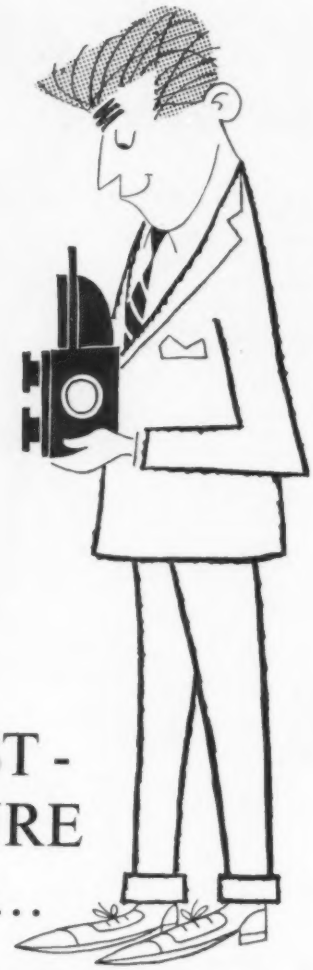

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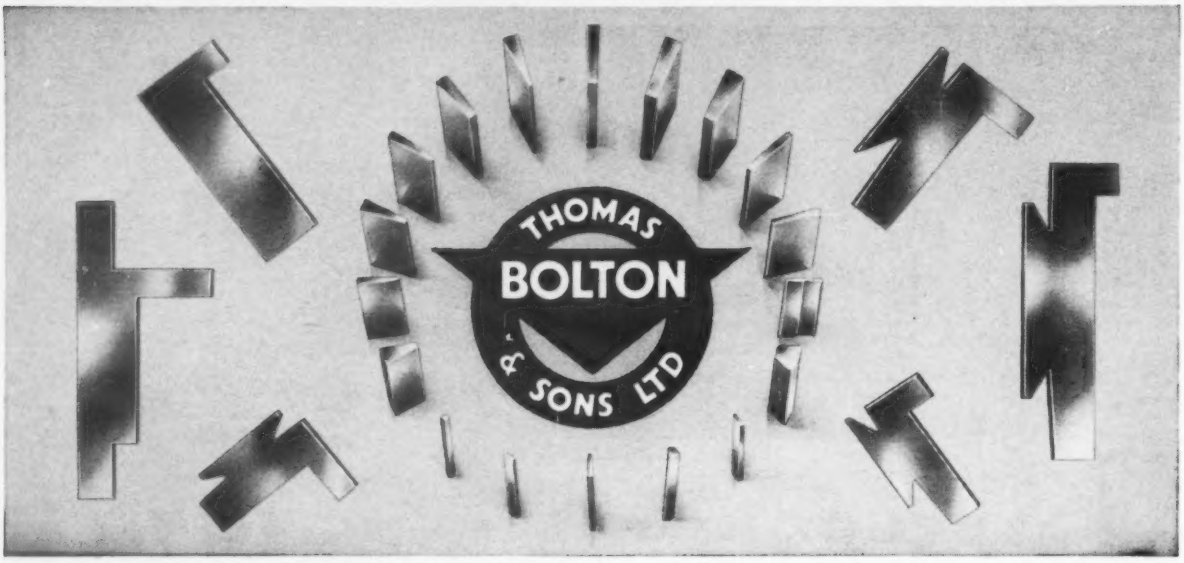

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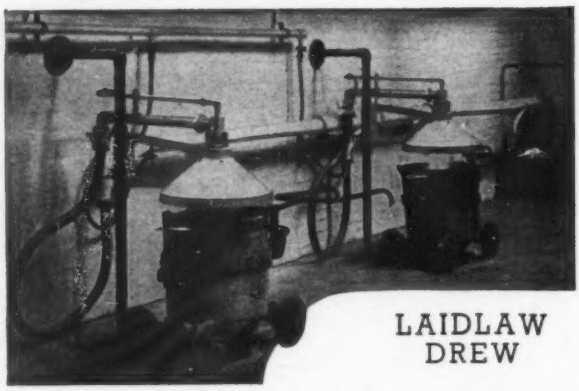

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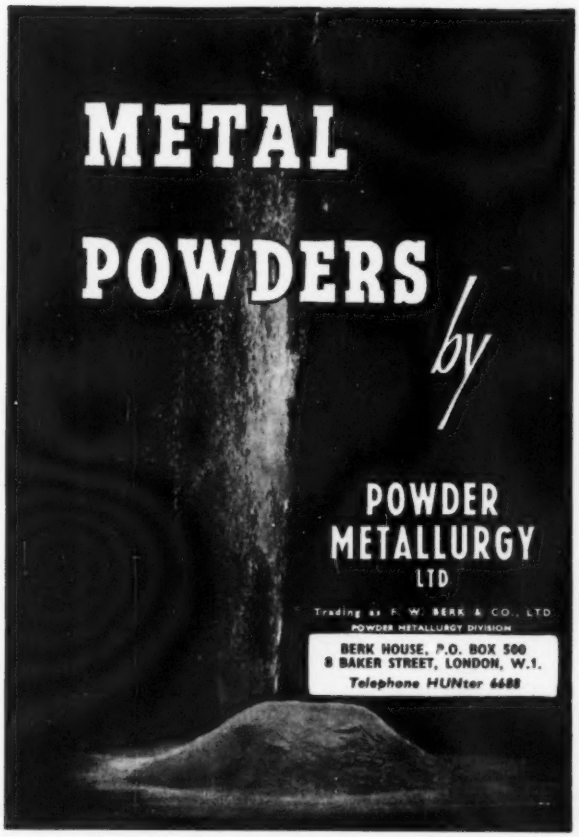

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